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THE BOEING COMPANY

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TITLE: 367-80 VARIABLE STABILITY SIMULATION SYSTEM
(NASA AMES LARGE TRANSPORT SIMULATION PROGRAM)

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MODEL 367-80 CONTRACT NAS2-3224

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ABSTRACT

Concerning the use of a large four-engine jet airplane, Boeing 367-80 (707 prototype) as an in-flight dynamic simulator for the simulation of other large transport type airplanes operating in the subsonic region, including the approach and landing phases of flight.

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ACTIVE SHEET RECORD

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d	B				

REVISIONS

LTR	DESCRIPTION	DATE	APPROVAL
A	Update information.	2/14/66	B.O. Smith
B	Drawing change on page 28; Reference title changed on page 3 and on page 60.	4/28/66	R.O. Smith

INTRODUCTION

During 1965, the Airplane Division of The Boeing Company undertook a program, utilizing the Boeing 367-80 airplane (707 prototype), which would provide in-flight dynamic simulation of large airplanes in their landing configurations. The bulk of the work was carried out under two separate NASA contracts. The first contract, NAS 1-4096, was for the simulation of large supersonic transport-type airplanes and the flight test program was conducted at the NASA Langley facility at Langley AFB, Virginia.

A description of the simulation system as used for the Langley program can be found in Boeing Document D6-19856, "367-80 Airplane Variable Stability Simulation System (NASA Langley Supersonic Transport Simulation Program)" (Ref. A), and the results of the program are detailed in Boeing Document D6-10743, "Simulation of Three Supersonic Transport Configurations with the Boeing 367-80 In-Flight Dynamic Simulation Airplane" (Ref. B).

The second contract, NAS 2-3224, was for the simulation of a very large subsonic transport-type airplane and the flight test work was performed at the NASA Ames Research Center at Moffett Field, California.

The objectives of this program were:

a. To establish requirements for satisfactory roll control characteristics of large, heavy airplanes in the landing approach.

b. To establish requirements for satisfactory and minimum acceptable longitudinal dynamic stability and control characteristics of large, heavy airplanes in the landing approach.

The subject document describes the simulation systems as used for the NASA Ames program and includes descriptions of the technique, hardware, operational procedures and the various configurations simulated.

The results of the NASA Ames Program are described in Boeing Document D6-15000 "Large Transport Landing Characteristics as Simulated in Flight and on the B
Ground" (Reference C). B

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LIST OF ILLUSTRATIONS

LIST OF SYMBOLS

V	Velocity
α	Angle of Attack
β	Angle of Sideslip - Wind from Right of Nose
θ	Pitch Angle - Nose Up
Q	Pitch Rate
ϕ	Roll Angle - Right Wing Down
P	Roll Rate
ψ	Yaw Angle - Nose Right
R	Yaw Rate
γ	Flight Path Angle - Climb
δ_E	Simulated A.L.T. Elevator
$\Delta T_{A.L.T.}$	Simulated A.L.T. Thrust
δ_W	Simulated A.L.T. Wheel
δ_R	Simulated A.L.T. Rudder
δe_c	-80 Elevator Command
δth_c	-80 Thrust Command
δab_c	-80 Spoiler Command
$\delta \omega_c$	-80 Wheel Command
δr_c	-80 Rudder Command
C_L	Lift Coefficient
C_D	Drag Coefficient
C_m	Pitching Moment Coefficient - Nose Up
C_ℓ	Rolling Moment Coefficient - Right Wing Down
C_n	Yawing Moment Coefficient - Nose Right
C_Y	Side Force Coefficient - To Right

LIST OF SYMBOLS (Continued)

T	Engine Thrust
m	Airplane Mass
I_{xx}	Roll Axis Inertia
I_{yy}	Pitch Axis Inertia
I_{zz}	Yaw Axis Inertia

1.0 SUMMARY

1.1 BACKGROUND

The Boeing 367-80 airplane (707 prototype) was successfully modified to perform as an in-flight dynamic simulator for the simulation of very large transport airplanes in the approach and landing phases of flight.

Thirty five hours of flight time were completed while simulating a large transport airplane, referred to as the Ames Large Transport (A.L.T.) and various variations from this basic configuration.

When the test airplane was in the simulation mode, it was flown from the right hand seat by the "Evaluation Pilot."

The airplane performance was continuously monitored by the "Safety Pilot" in the left hand seat, who could take command at any time and revert to the normal 367-80 control systems by disengaging the simulation.

The Safety Pilot could also override the Evaluation Pilot's inputs with his own controls without disengaging the system.

1.2 CONFIGURATIONS TESTED

The basic configuration simulated was based on control and stability derivatives supplied by NASA Ames that were typical of a very large four-engine, subsonic jet transport airplane. The basic derivatives of this airplane, referred to as the Ames Large Transport (A.L.T.), are given in Appendix A, Sheet A30.

In addition, a number of variations were simulated which consisted of modified lateral directional and longitudinal axis characteristics.

The parameters modified were:

a. **Lateral-Directional Axis**

Maximum Wheel Angle
Maximum Wheel Rate
Maximum Rolling Acceleration
Maximum Steady State Roll Rate
Roll Time Constant

b. **Longitudinal Axis**

Short Period Frequency
Short Period Damping
Elevator to Column Gearing
Elevator Control Power
Change of Lift Coefficient Due to Elevator

1.3 AIRCRAFT MODIFICATIONS

The modifications necessary to convert the 367-80 to a variable stability research airplane consisted of:

Conversion of the airplane to fully powered control surfaces by the addition of electro-hydraulic actuators. This gave the capability of moving the control surfaces by either a mechanical input from the Safety Pilot through the normal airplane control cable systems, or by an electrical command input when in the simulation mode. In addition, provision was made for modulating the positions of the spoiler panels and the thrust reverser clamshell doors with electrical commands.

The installation of a general purpose analog computer (Systron-Donner SD/80) which provided electrical command signals to the airplane control systems - elevators, ailerons, spoiler panels, rudder, and thrust reversers - to modify the response characteristics of the basic -80 airplane to conform to those of the A.L.T. configuration being simulated.

The installation of a special set of Evaluation Pilot's controls for the right hand seat position. These controls consisted of an instrumented column and wheel, a fake throttle lever and transducers on the existing rudder pedals, and provided electrical signals proportional to the Evaluation Pilot's control inputs. Electrical pitch and roll trim controls were also added.

The installation of special sensors and wiring for the measurement of such parameters as angle-of-attack, sideslip angle, pitch, roll and yaw rates, roll angle and airspeed. A 17-foot streamlined boom was added to the nose of the airplane to carry the $\alpha\beta$ vane sensor. (See Fig. 1.)

The installation of a rack of special test equipment, referred to as the interface, which provided:

a. Input and output connections to the computer.

b. Isolation and demodulation, where necessary, for the signals from the various airplane sensors and proper scaling and biasing of the incoming and outgoing signals.

c. Electronic control for the electro-hydraulic servo systems.

d. Logic circuitry for the mode selection control allowing the simulation mode to be selected from either the cockpit or the interface station. This function also included error detection and display circuitry and provisions for automatic disengagement in the event of a malfunction.

1.4 TECHNIQUE OF SIMULATION

The technique adopted for the simulation system was essentially an open loop, low-gain compensation technique in which the response of the airplane to any disturbance was modified by modulating the airplane control surface with electrical commands from the analog computer. Figure 15 shows a very simplified block diagram of the system.

The magnitudes of the electrical commands were obtained from the precalculated differences between the response of the basic 367-80 airplane and the response of the simulated A.L.T. to the same disturbance. They were based on the known stability and control derivatives of the 367-80 and the predicted derivatives of the simulated A.L.T.

The accuracy of the simulation depended primarily upon the accuracy with which the control and stability derivatives of the basic 367-80 were known. For this reason, the initial calculations for the gains used in the analog computer were followed up with flight tests for the purpose of "fine tuning" the simulation system to compensate for any discrepancy between the published values of the airplane derivatives and the true values under dynamic conditions.

This technique, unlike a high gain, closed loop feedback, or model following method, is not self-correcting and consequently has limitations regarding gross weight, c.g. location, etc., changes of which tend to affect the validity of the simulation.

Despite these drawbacks, the technique adopted was considered preferable to the model following method because of the high probability of structural bending modes coupling with a model system.

1.5 FACTORS AFFECTING THE ACCURACY OF THE SIMULATION

1.5.1 Linearization of the Equations of Motion

Because the computation system was based on linearized equations of motion for a rigid airframe, the validity of the simulation decreased as the airplane departed from the established trim condition. For this reason the following limits were established to keep the simulation within the desired accuracy:

Airspeed	± 10 knots from trim speed
Bank Angle	± 20 degrees
Sideslip Angle	± 10 degrees
Load Factor.	± .6 g's

1.5.2 Knowledge of the Basic 367-80 Characteristics

The accuracy with which the basic 367-80 airplane could be simulated had a major effect on the overall simulation accuracy.

This factor became increasingly important if the airplane being simulated was radically different from the 367-80.

1.5.3 Accuracy of the Signals from Aircraft Sensors

The accuracy of the signals from the various aerodynamic sensors, i.e., angle-of-attack, sideslip angle, roll, yaw and pitch rates, roll angle and airspeed, was important since these signals fed directly into the computer to form the commands to the control surfaces.

1.5.4 Response Characteristics of the Control Surfaces

A further factor affecting the accuracy of the simulation was the response characteristics of the control surfaces. This included the frequency response of the servo systems plus any non-linearities in the linkage, and effects due to airloads.

1.5.5 Variations in Gross Weight and C.G. Location

Because the simulation was based on calculations assuming a 367-80 airplane of fixed gross weight and c.g. location any change in these two factors, due perhaps to fuel distribution before flight and consumption during flight, caused a deterioration in the simulation.

1.5.6 Atmospheric Conditions

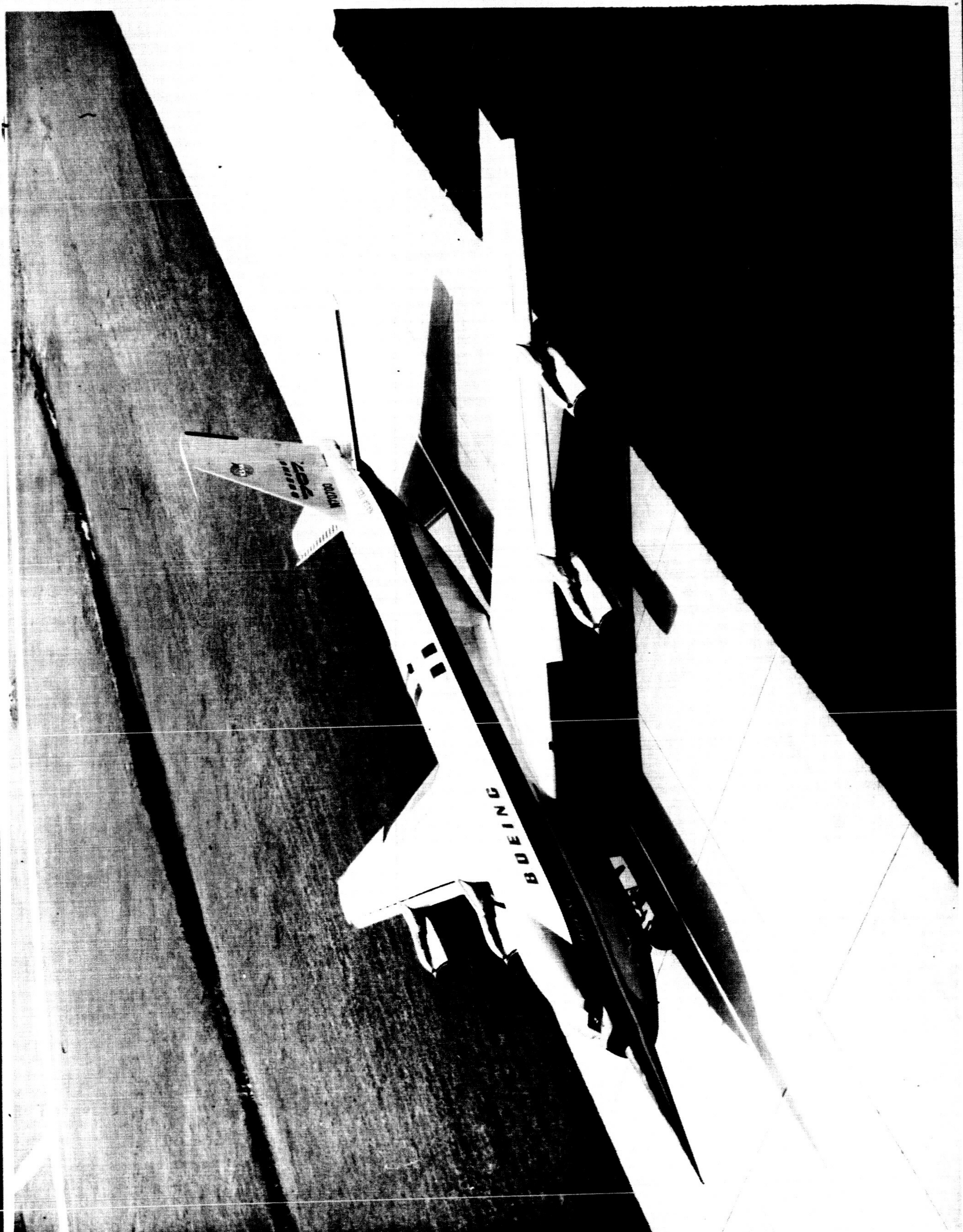
The above paragraphs refer to factors which were more or less under the control of the test engineer.

The 367-80 aerodynamic derivatives could be improved by means of increased flight time and increased knowledge of the basic -80 airplane characteristics.

The signals from the aircraft sensors could be improved with careful calibration and compensation.

The discrepancies caused by using linear equations of motion could be calculated and limits set on the simulation to keep the accuracy within reasonable bounds. Similarly, the effects of change in gross weight and c.g. location could be calculated and allowed for.

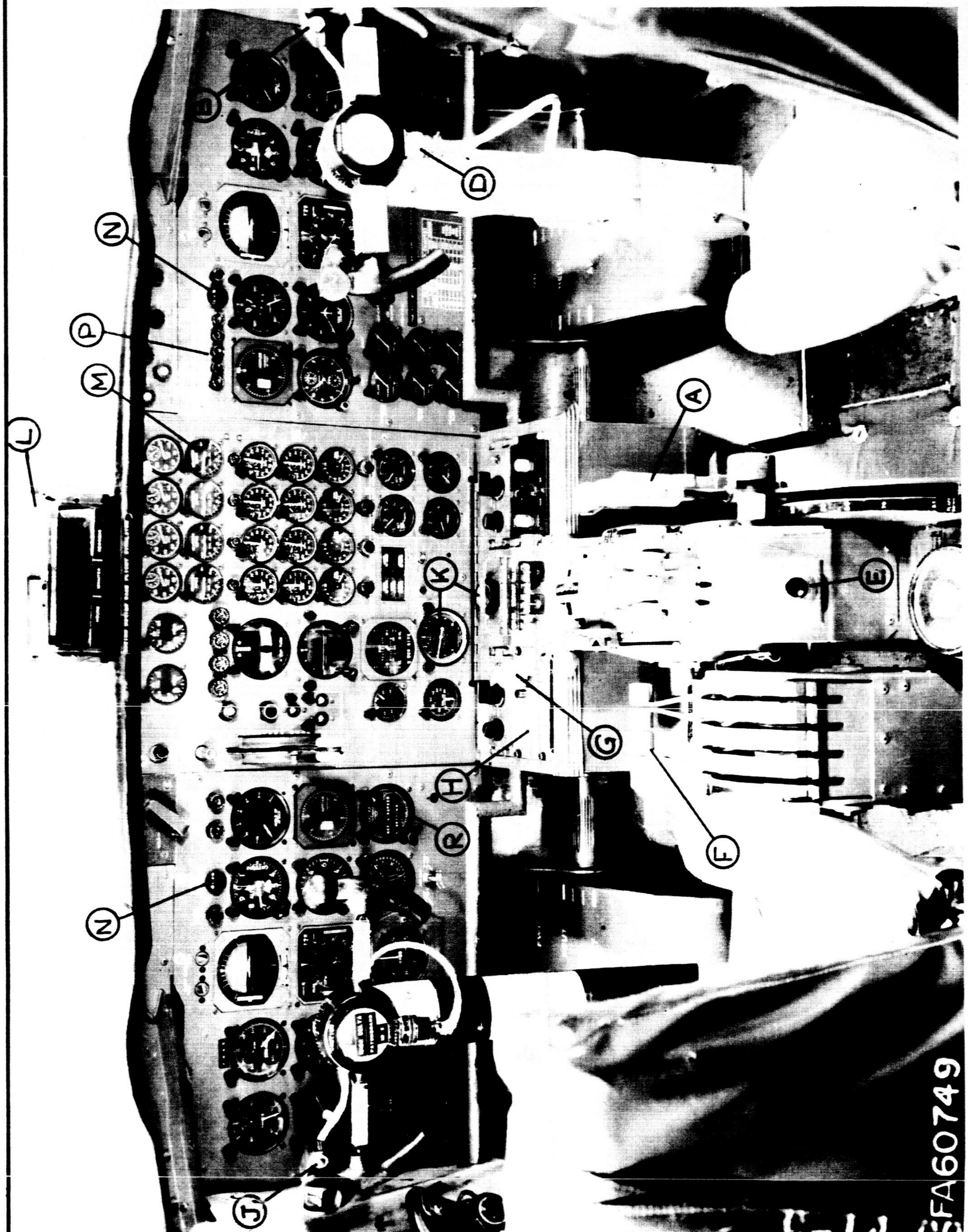
However, the one factor which was out of the control of the test engineer was atmospheric turbulence. The major part of the problem with turbulence was caused by the production of erroneous angle-of-attack and sideslip angle readings due to local gusts at the $\alpha\beta$ vane. These signals were immediately fed into the computer resulting in commands to the control surfaces which caused erroneous motions of the airplane. For this reason the flight testing was restricted to conditions of zero to light turbulence.



GENERAL VIEW OF 367-80 AIRPLANE

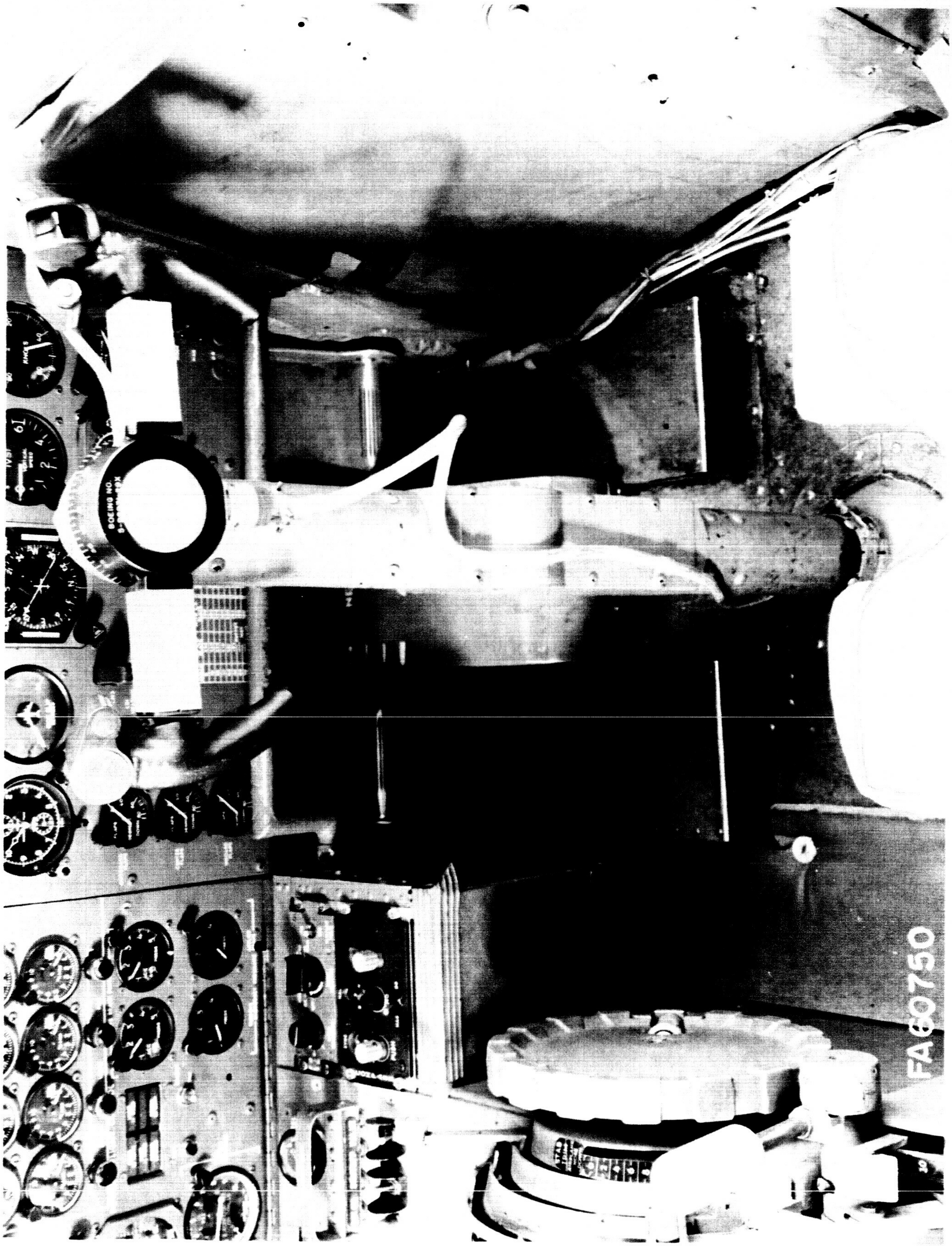
SHEET 12

FIG. 1



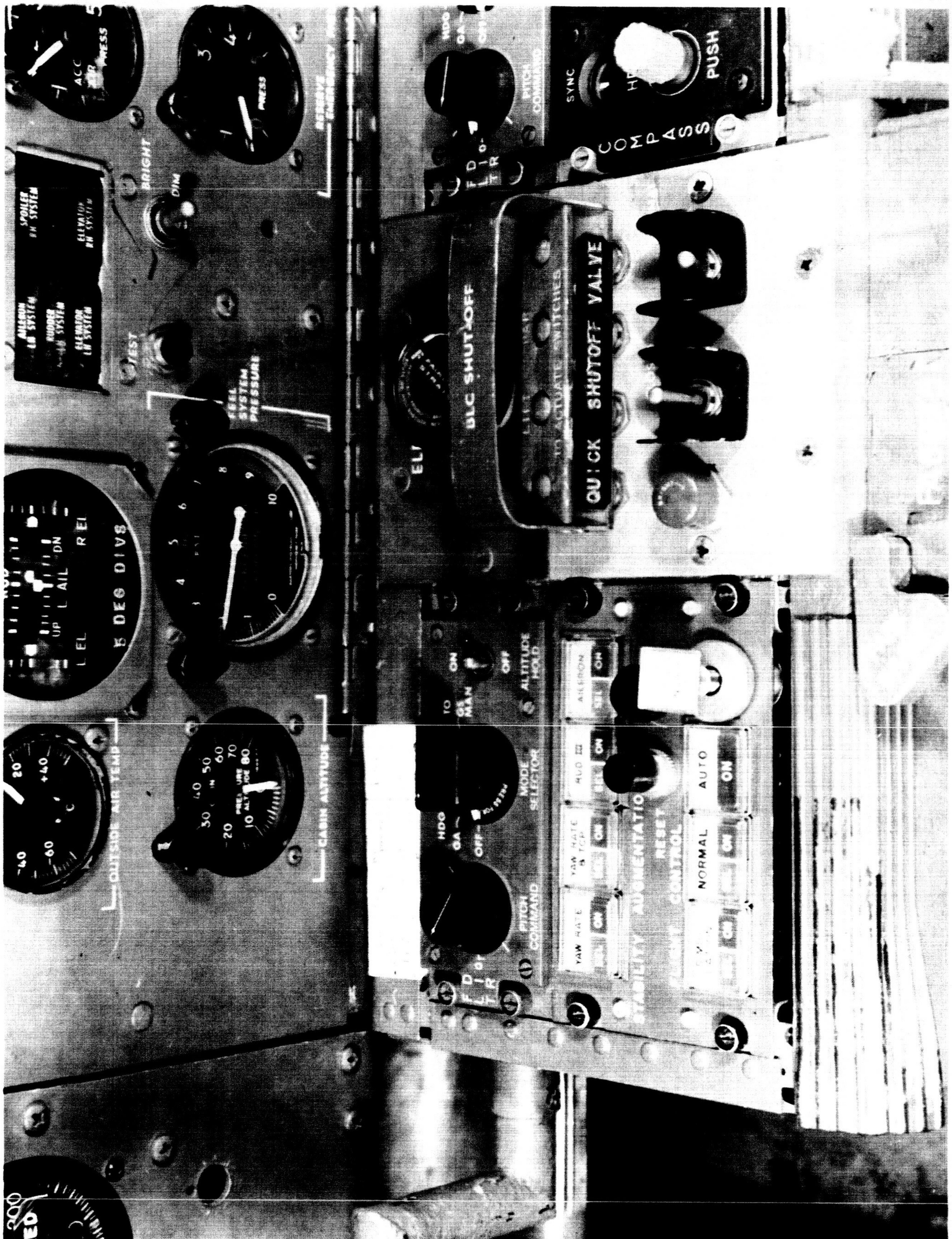
GENERAL VIEW OF CABIN AREA

FIG. 2



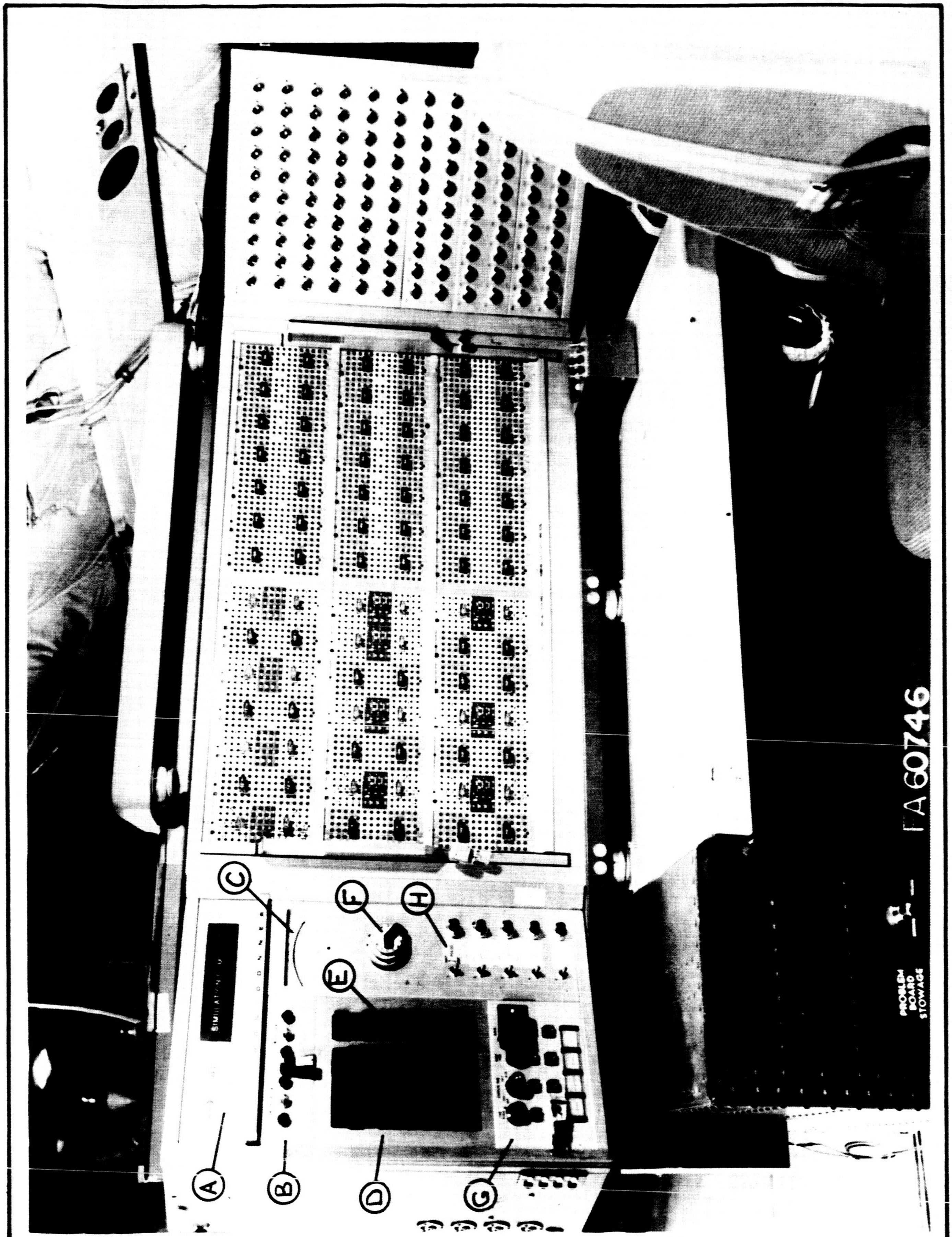
CLOSE-UP OF EVALUATION PILOT'S CONTROLS

FIG. 3



CLOSE-UP OF PILOT'S SIMULATION CONTROL PANEL

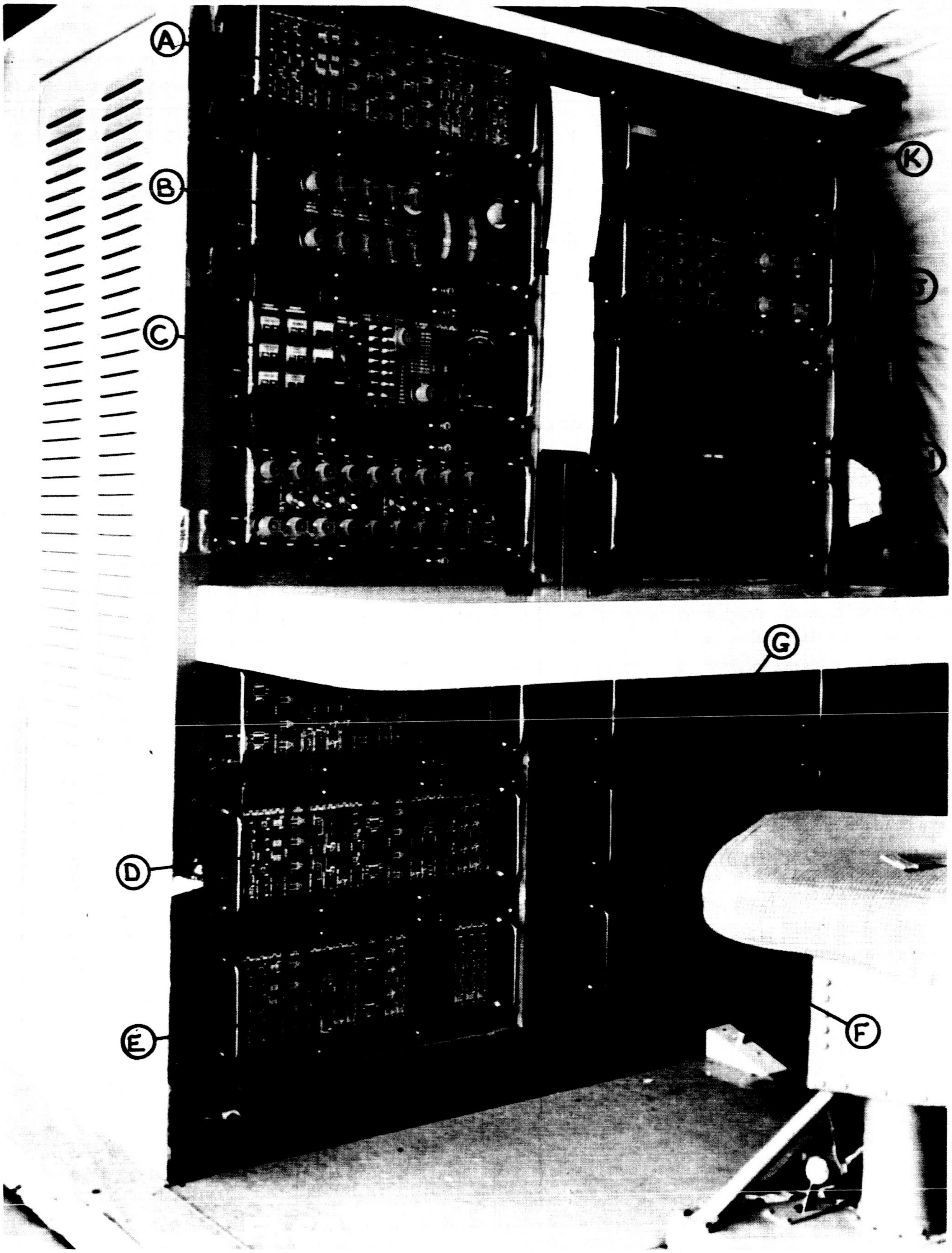
FIG. 4



GENERAL VIEW OF AIRBORNE ANALOG COMPUTER

SHEET 16

FIG. 5



GENERAL VIEW OF INTERFACE

FIG. 6

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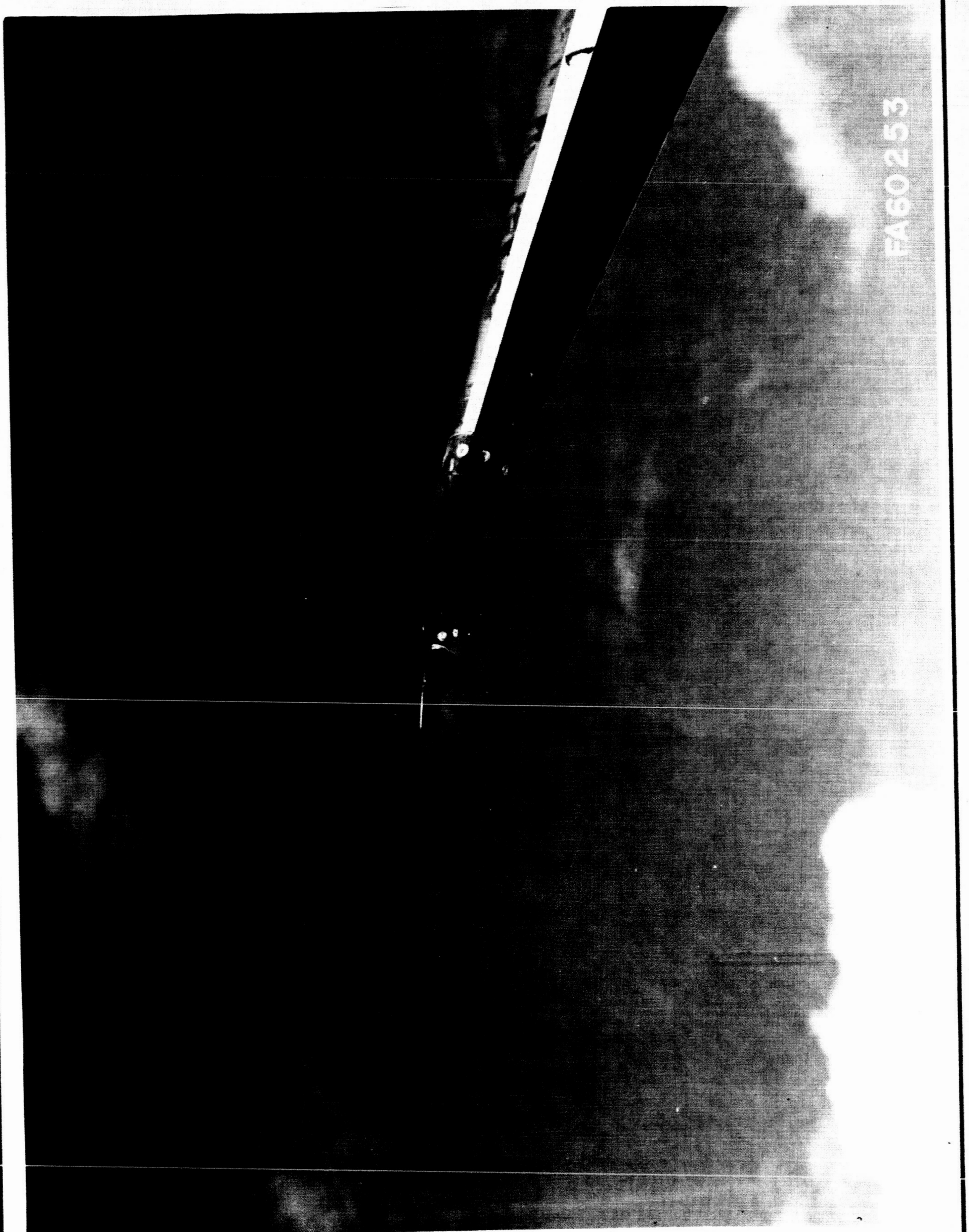


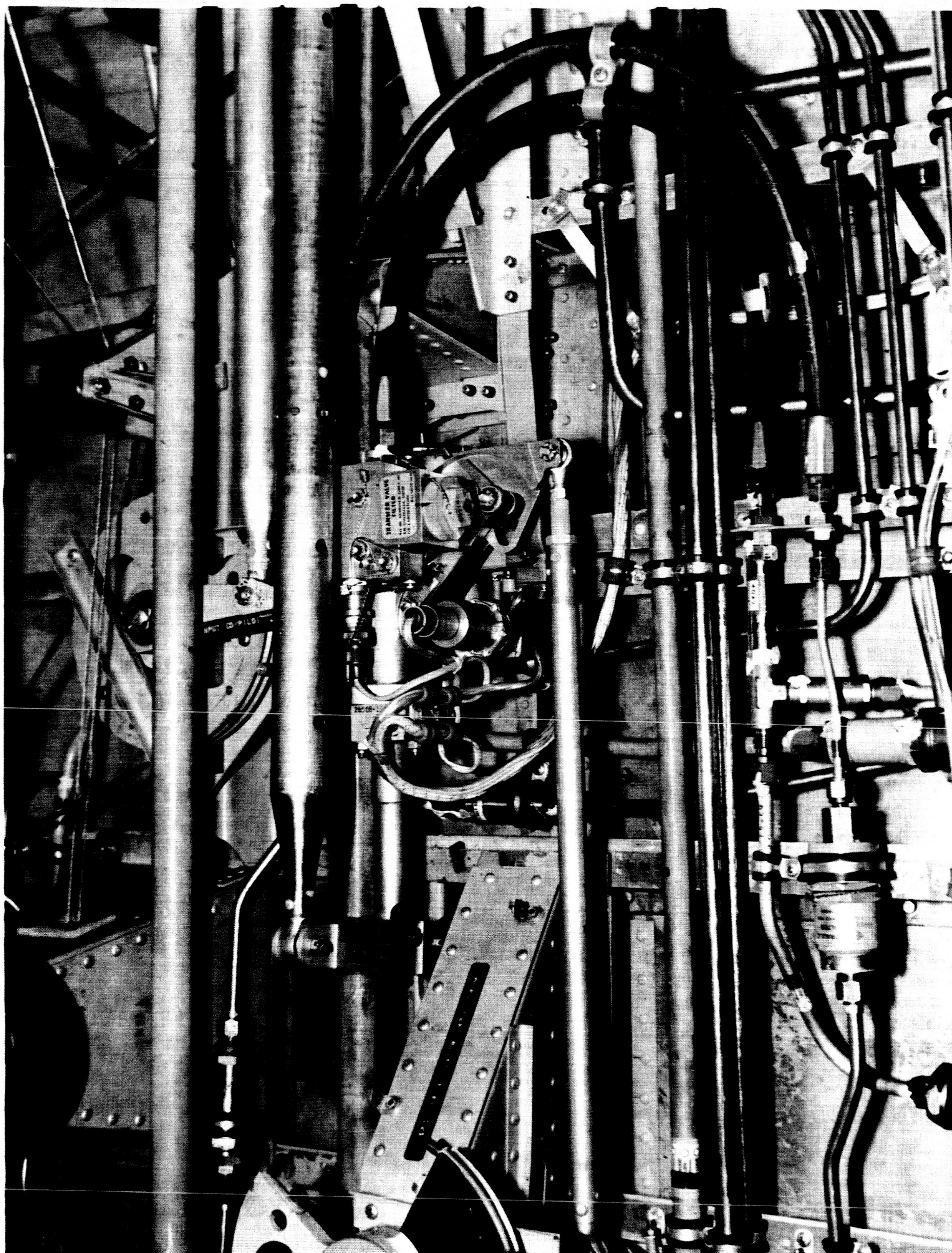
CLOSE-UP OF α/β VANE

SHEET 18

FIG. 7

CLOSE-UP OF RATE GYROS

FIG. 8



LATERAL CONTROL POWER UNIT (R.H. WHEEL WELL)

FIG. 9

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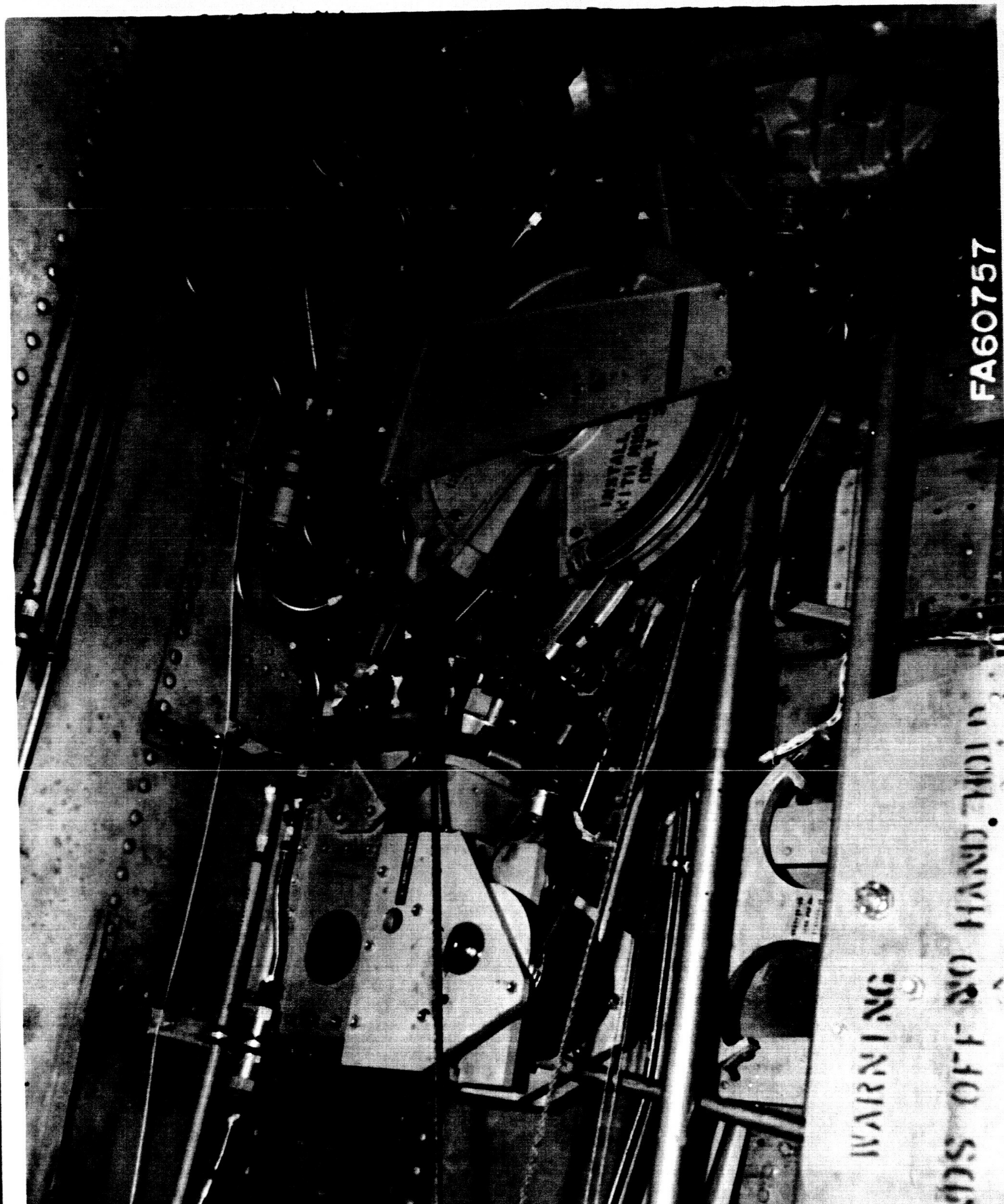

AILERON ACTUATOR (L.H. WHEEL WELL)

FIG. 10

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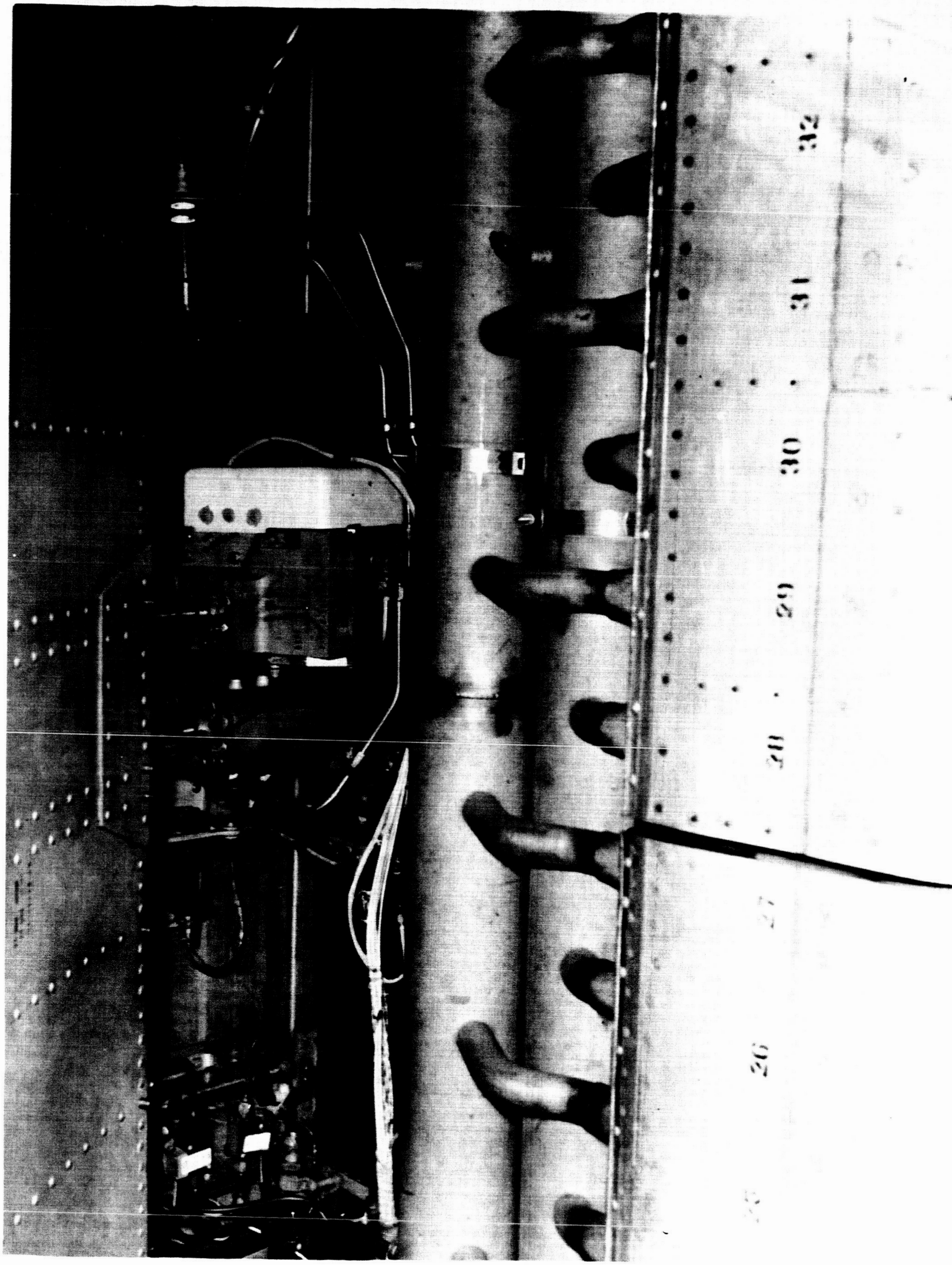
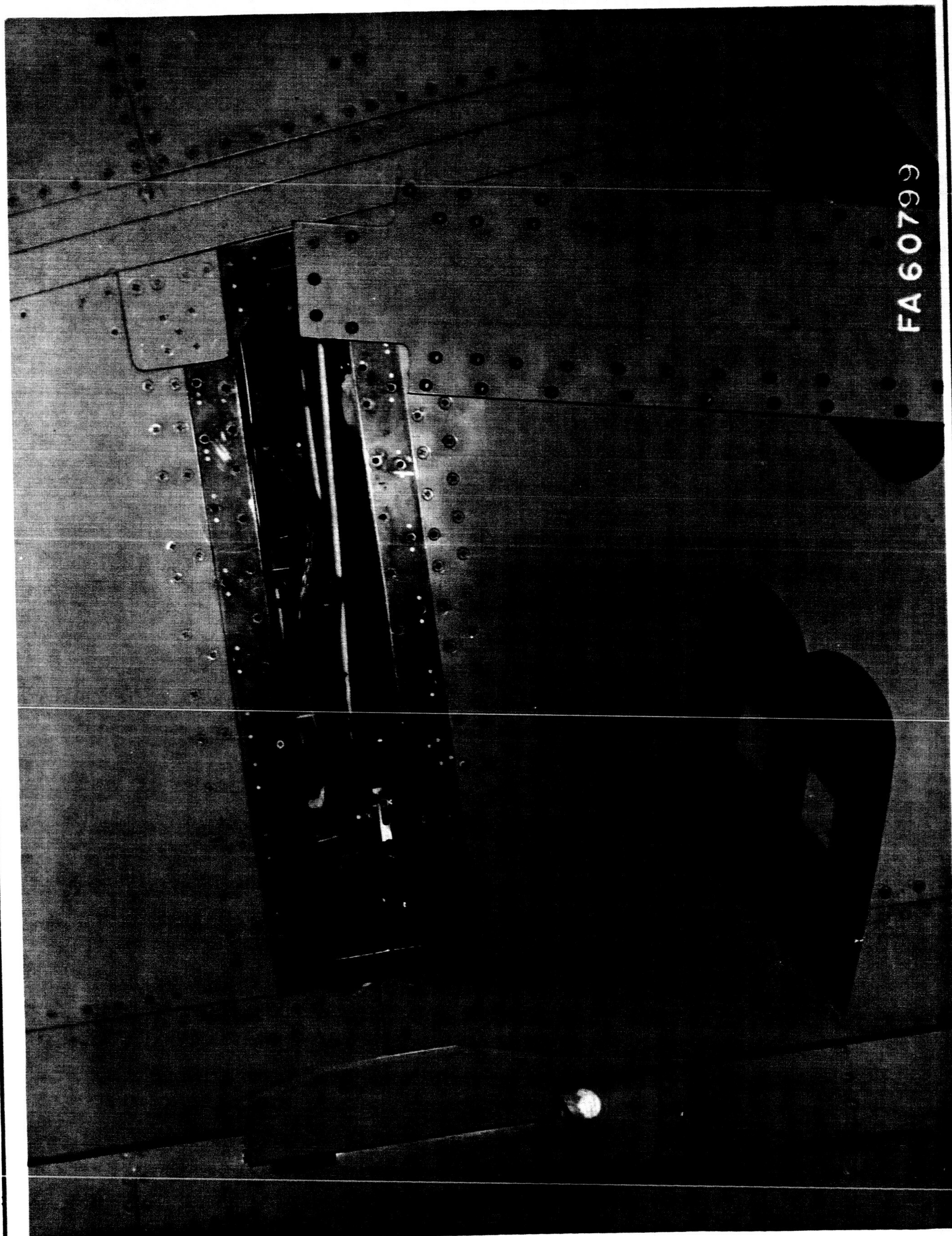


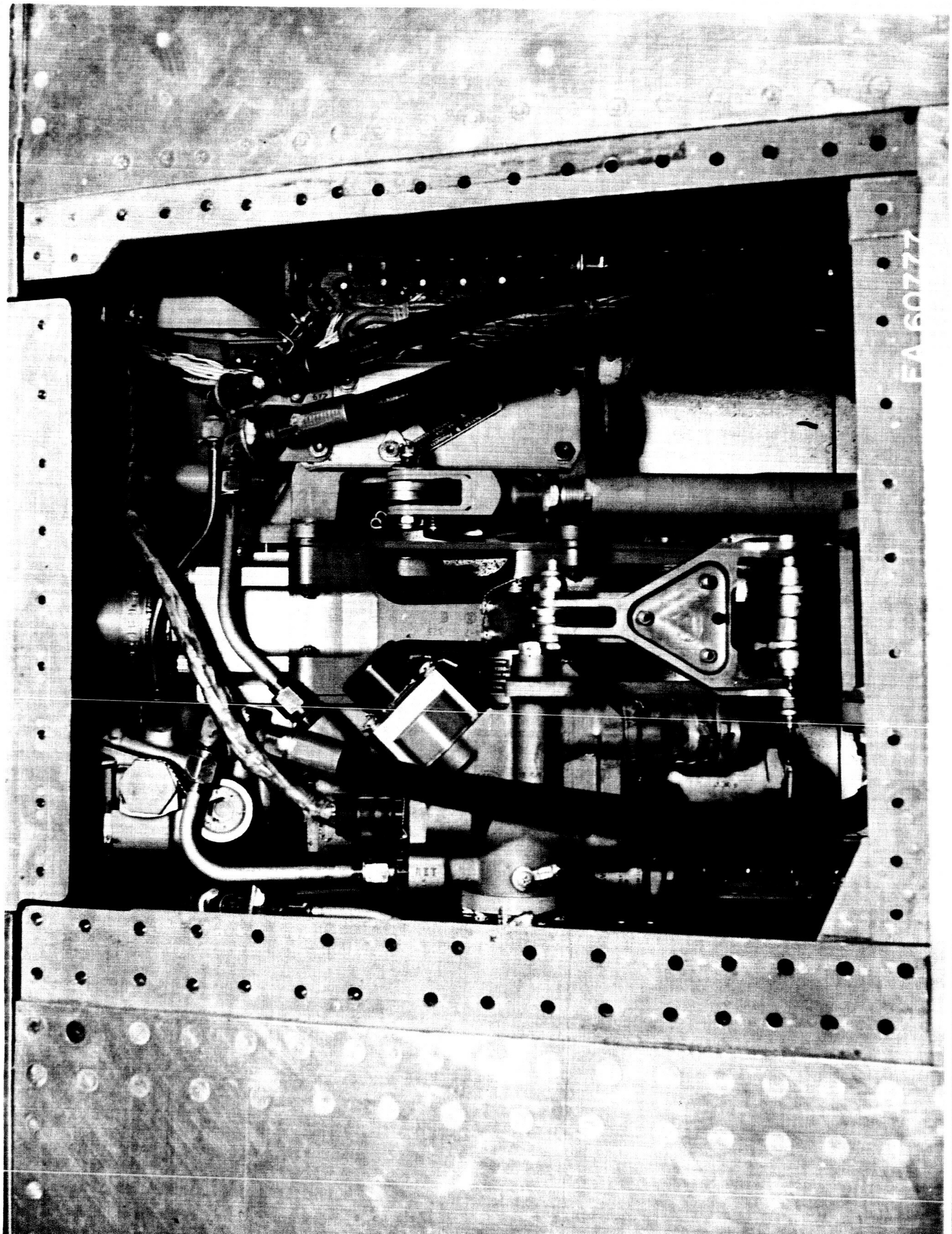
HYDOMAT UNIT ~ SPOILER PANEL #6

FIG. 11



RUDDER ACTUATOR

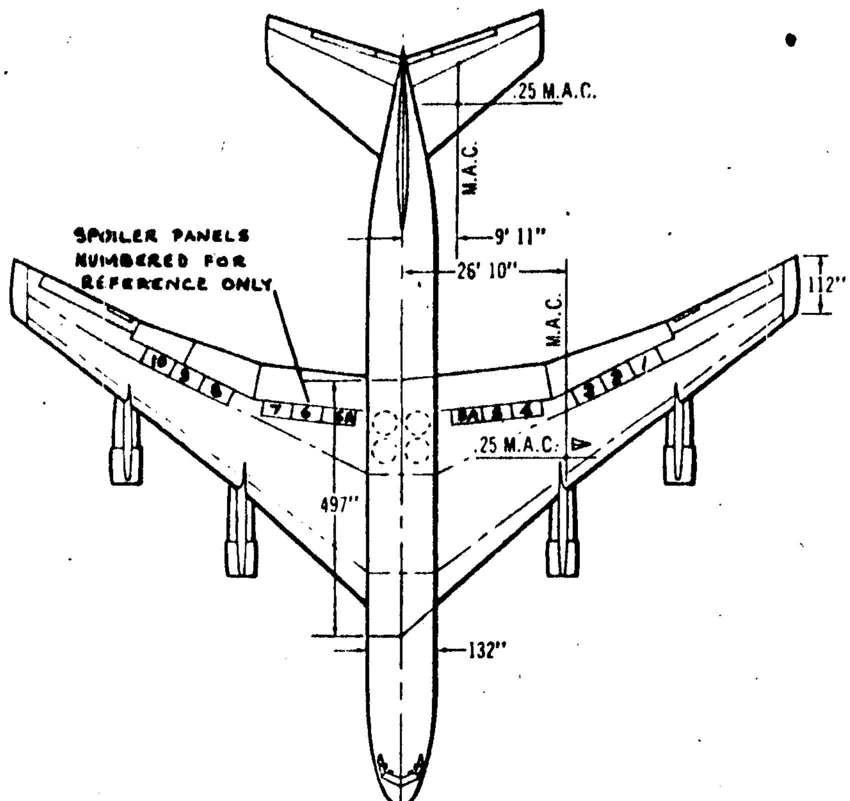
FIG. 12



R.H. ELEVATOR POWER CONTROL UNIT

FIG. 13

MODEL 367-80 CHARACTERISTICS



TOP VIEW

WING

Area	2,821.36 Ft^2
Aspect Ratio	6.00
Sweep (.25C)	35°
Dihedral	7°
Incidence	2°
M.A.C.	20.05 Ft

POWER PLANT

Four Pratt & Whitney Model JT3D-1 Turbofan Jet Engines

HORIZONTAL TAIL

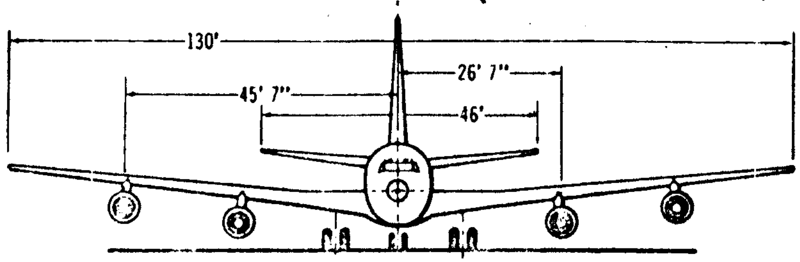
Area (Increased to)	625 Ft^2
Aspect Ratio	3.37
Taper Ratio	.421
Sweep (.25C)	35°
Dihedral	7°

VERTICAL TAIL

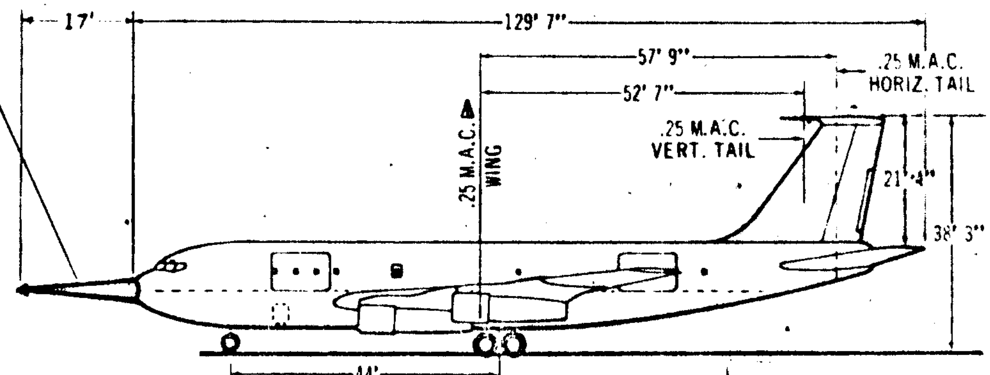
Area(excl.dorsal)	312 Ft^2
Aspect Ratio (excl.dorsal)	1.46
Taper Ratio (excl.dorsal)	.45
Sweep .25C	31°

Maximum Gross Weight = 18[illegible],000 Pounds

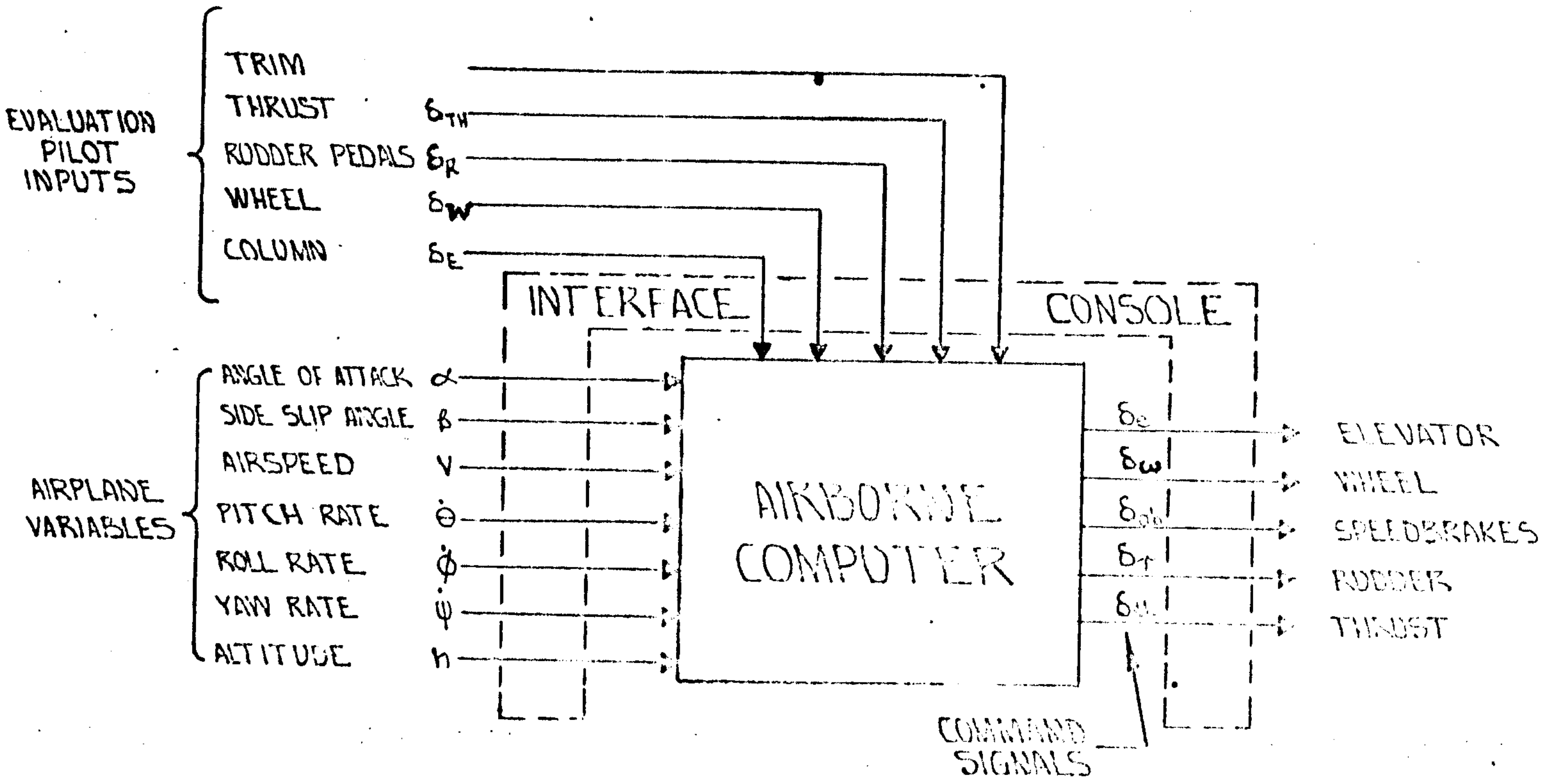
NOSE BOOM FOR α-β SENSOR
(NOT SHOWN IN TOP VIEW)



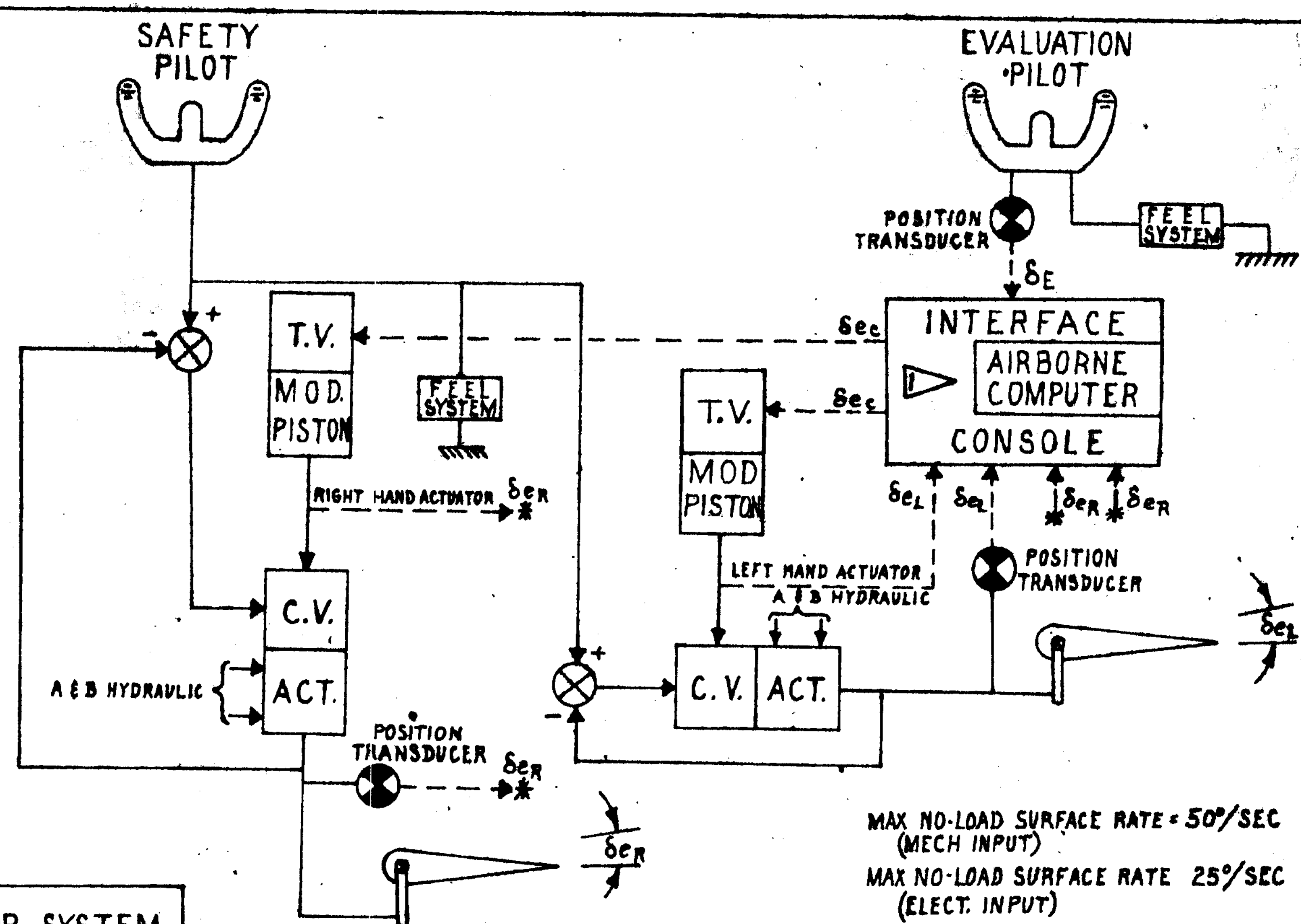
FRONT VIEW



SIDE VIEW



AIRBORNE COMPUTER
367-80 A.L.T. SIMULATION



MAX NO-LOAD SURFACE RATE = 50°/SEC (MECH INPUT)

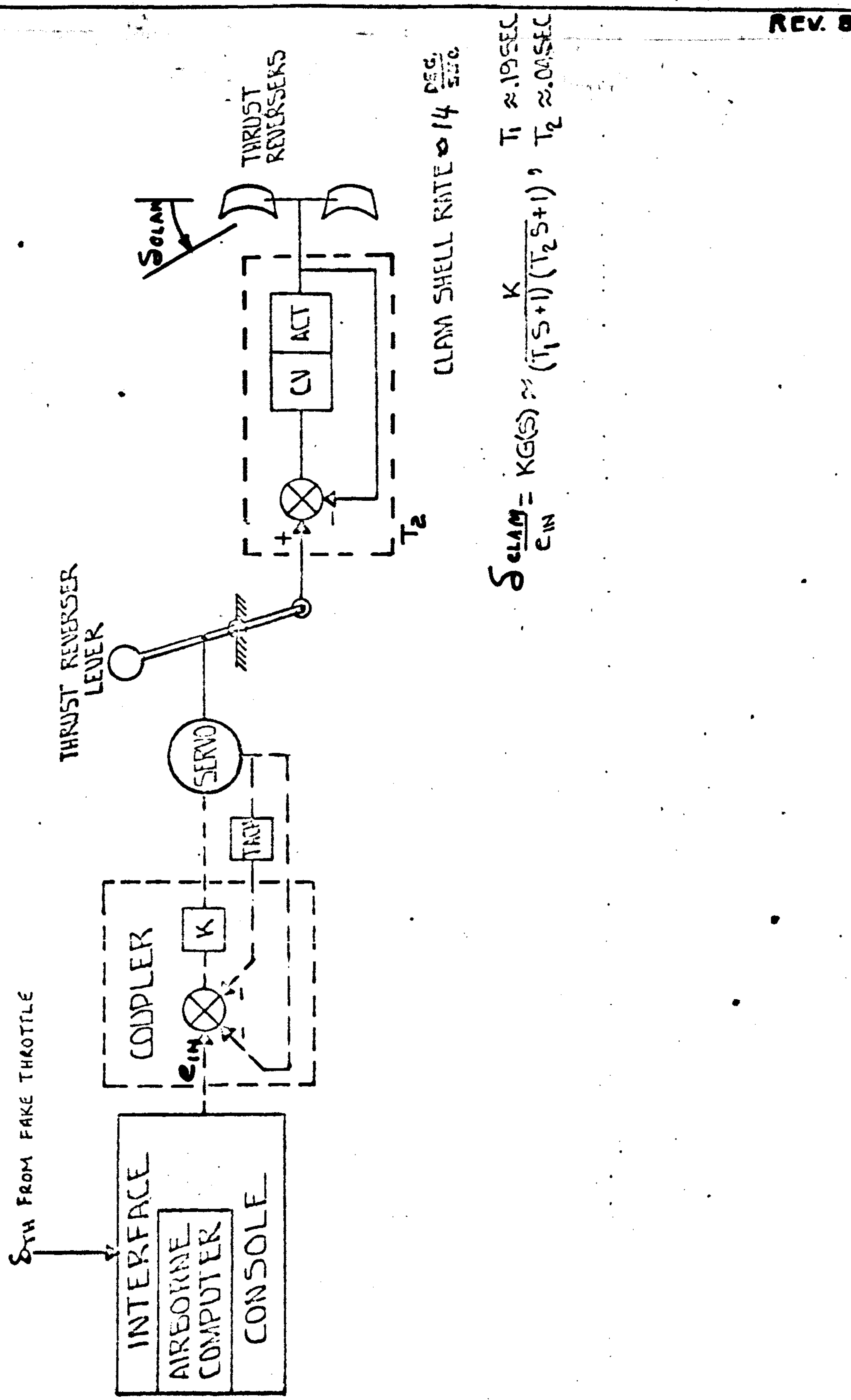
MAX NO-LOAD SURFACE RATE 25°/SEC (ELECT. INPUT)

ELEVATOR LIMIT = .5-1g MANEUVER

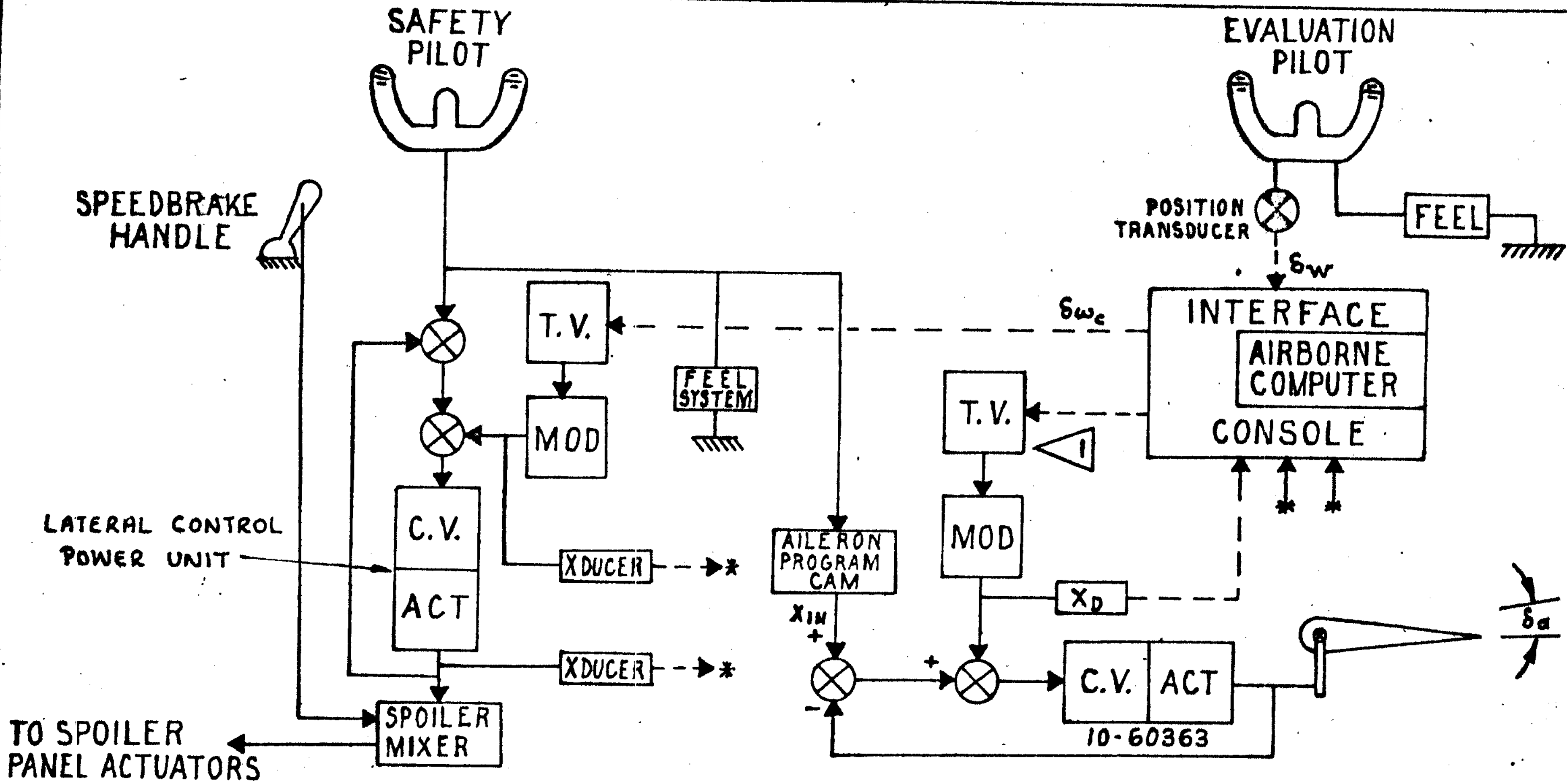
$$\frac{\delta_e}{e_{IN}} = KG(S) \approx \frac{K}{TS+1}, \quad T \leq .06$$

1 RIGHT OR LEFT SYSTEM SELECTED AS MASTER ON "FLY BY WIRE".

367-80 ELEVATOR SYSTEM FOR ALT SIMULATION



367-80 THRUST CONTROL SYSTEM



δ_a MAX NO-LOAD RATE = 68°/SEC (MECH INPUT)

δ_a MAX NO-LOAD RATE = 68°/SEC

<u>MANUAL POWER</u>

$$\frac{\delta_a}{X_{IN}} = KGS = \frac{183}{.05S+1}$$

ROLL STABILITY AUGMENTATION

$$\frac{\delta_a}{e_{IN}} = \frac{K}{(.014S+1)(.05S+1)}$$

δ_{SP} NO-LOAD RATE = 50°/SEC

<u>MANUAL POWER</u>

$$\frac{\delta_{SP}}{INPUT} = KG(S) = \frac{K}{.06S+1}$$

<u>ELECTRICAL</u>

$$\frac{\delta_{SP}}{e_{IN}} = KG(S) = \frac{K(23)^2}{S^2+(.7)(23)S+(23)^2}$$

367-80 LATERAL CONTROL SYSTEM FOR A.L.T. SIMULATION

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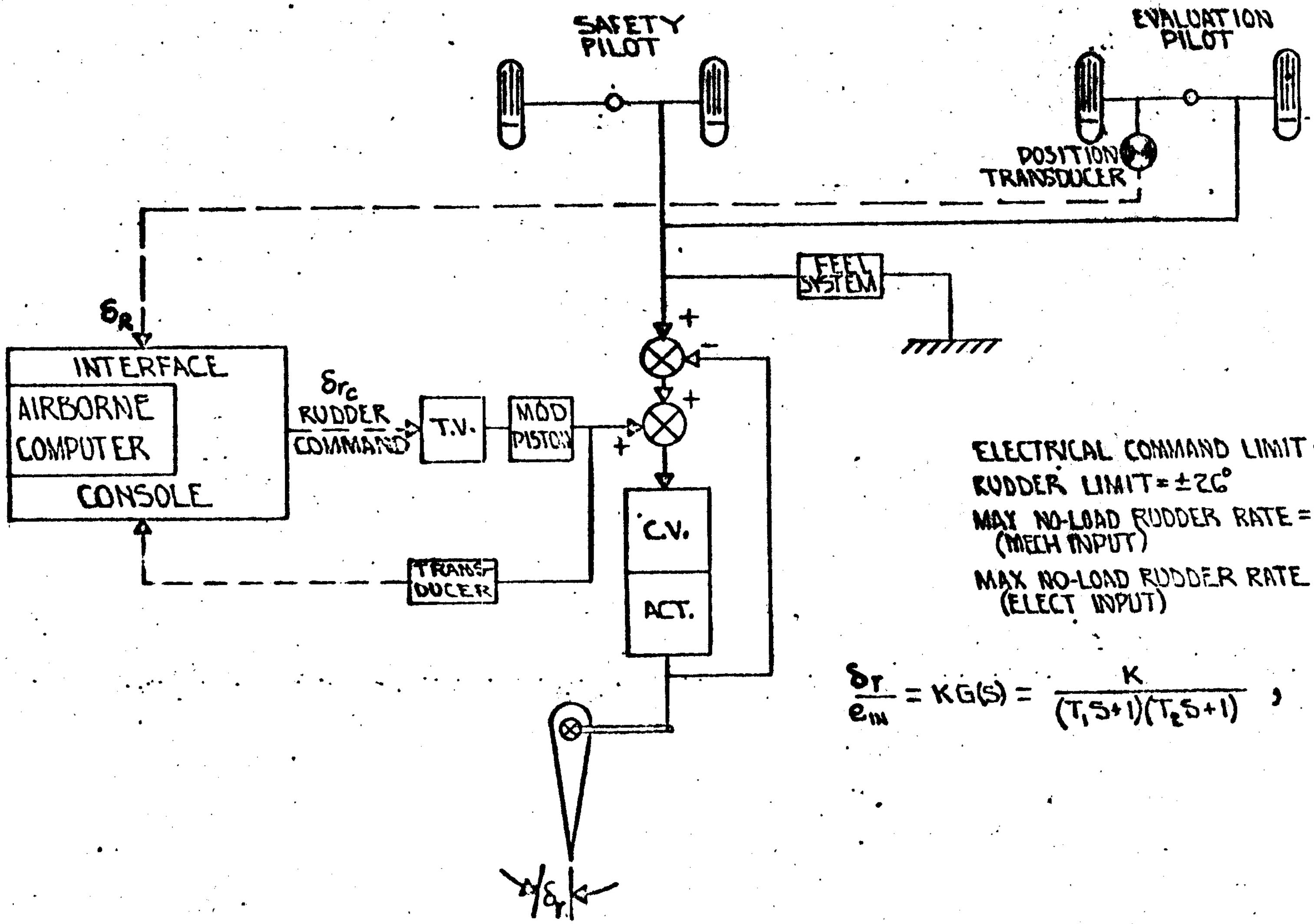


ELECTRICAL COMMAND LIMIT = ±10° δ_r

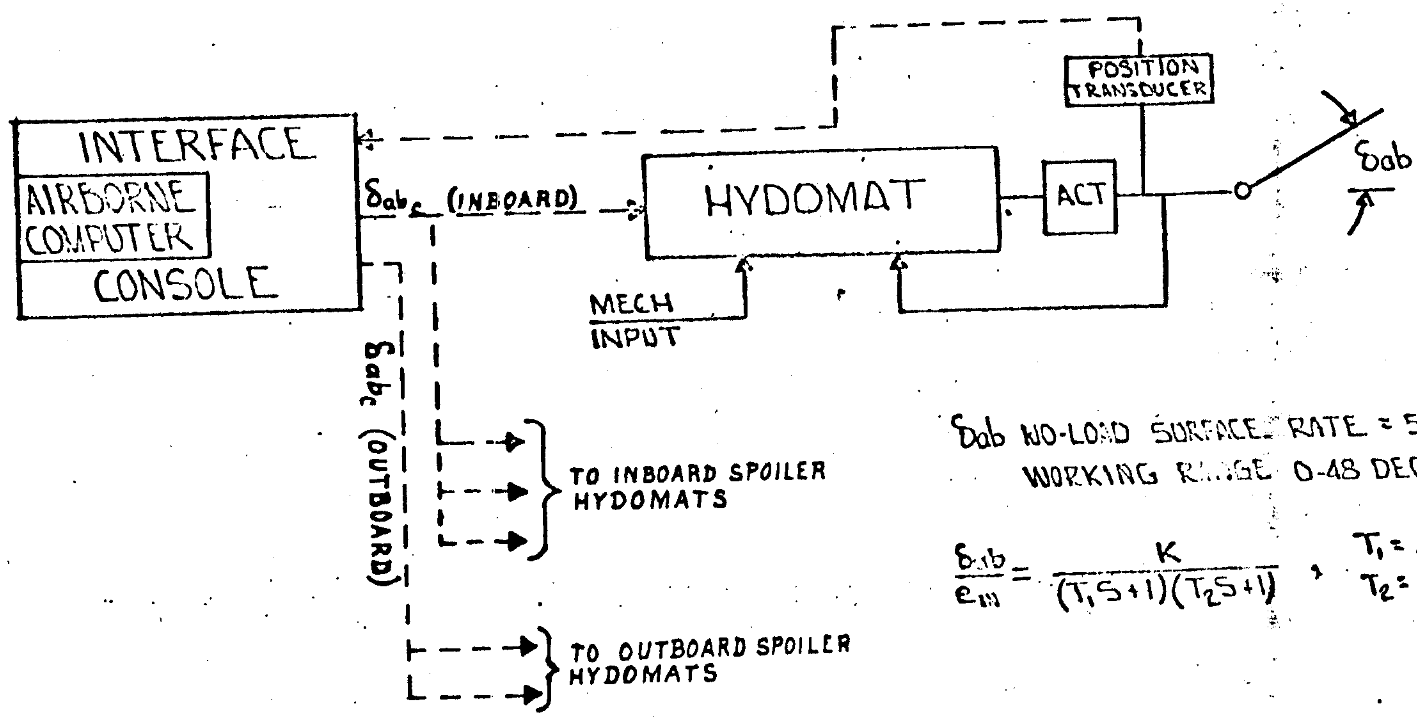
RUDDER LIMIT = ±26°

MAX NO-LOAD RUDDER RATE = 33 $\frac{DEG}{SEC}$ (MECH INPUT)

MAX NO-LOAD RUDDER RATE = 33 $\frac{DEG}{SEC}$ (ELECT INPUT)

$$\frac{\delta_r}{e_{in}} = KG(S) = \frac{K}{(T_1 S+1)(T_2 S+1)}, \quad T_1 = .063, \quad T_2 = .028$$

367-80 RUDDER CONTROL SYSTEM FOR A.L.T. SIMULATION



δ_{ab} NO-LOAD SURFACE RATE = 50°/SEC
WORKING RANGE 0-48 DEGREES

$$\frac{\delta_{ab}}{e_{in}} = \frac{K}{(T_1S+1)(T_2S+1)}, \quad T_1 = .1 \text{ SEC}, \quad T_2 = .03 \text{ SEC}$$

367-80 LIFT CONTROL SYSTEM

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2.0 DESCRIPTION AND OPERATION OF SIMULATION SYSTEM

2.1 BASIC THEORY

The 367-80 in-flight variable stability system provides a five degree-of-freedom simulation of large jet aircraft operating at subsonic speeds.

The technique adopted (called response feedback) is to modulate the control surfaces of the 367-80 aircraft in such a manner as to cause the aircraft to behave in the manner predicted for the particular configuration being simulated.

The correct roll, yaw and pitch motions of the aircraft are produced by modulating the lateral controls, rudder and elevator, respectively. The correct lift and normal acceleration characteristics are obtained by modulating the wing-mounted spoiler panels, and the correct drag by modulating the engine thrust reversers. There is no simulation of side force, but studies have shown that the errors introduced by this omission are small enough to be neglected.

The controls are moved by electrical commands to the appropriate actuators or servos. The commands are produced by a Systron-Donner SD/80 general purpose analog computer which forms the heart of the simulation system. A brief step-by-step description and example of how these commands are generated follows:

a. The calculations are all based on the linearized equations of motion for a rigid airframe (see Appendix A), e.g., the pitch axis equation is:

$$I_{YY}\dot{Q} = q_0 S \bar{c}\left(C_{m_\alpha}\cdot\Delta\alpha + C_{m_{\dot{\alpha}}}\cdot\dot{\alpha} + C_{m_Q}\cdot Q + C_{m_{\delta_e}}\cdot\delta_e + C_{m_{\delta_{ab}}}\cdot\delta_{ab} + C_{m_{\Delta T}}\cdot\Delta T + C_{m_{\Delta V}}\cdot\Delta V\right)$$

b. The equations are used to mechanize a linearized simulation of the 367-80 airplane on the SD/80 computer; and as a basis for deriving the equations giving the summation of forces along, and the moments about, the X, Y, and Z axes. The equation for the linear acceleration experienced by the aircraft in the Z direction, for example, is:

$$\ddot{Z} = \frac{-T_\alpha}{m}\Delta\alpha - \frac{\alpha_0}{m}\Delta T - g\left(\cos\Theta_W \cos\phi_W - 1\right) - 2\frac{q_0 S}{m V_0}C_{L_{TRIM}}\Delta V - \frac{q_0 S}{m}\left(C_{L_\alpha}\cdot\Delta\alpha + C_{L_{\delta_{ab}}}\cdot\delta_{ab}\right)$$

c. Now, if the 367-80 airplane is to simulate the behavior of a large transport airplane, then the linear and angular accelerations that it experiences for any given conditions must be identical to those that would be experienced by this airplane under the same conditions.

AD 4572

2.1.c **BASIC THEORY (Continued)**

Thus, the equations derived in Step b. can be written down twice; once, using the known stability and control derivatives of the 367-80 (designated by the suffix -80) and; secondly, using the predicted derivatives of the A.L.T. configuration being simulated (designated by the suffix A.L.T.). Then, using the identities,

$$\ddot{X}_{-80} = \ddot{X}_{A.L.T.}$$
$$\ddot{Y}_{-80} = \ddot{Y}_{A.L.T.}$$
$$\ddot{Z}_{-80} = \ddot{Z}_{A.L.T.}$$
$$\dot{P}_{-80} = \dot{P}_{A.L.T.}$$
$$\dot{Q}_{-80} = \dot{Q}_{A.L.T.}$$
$$\dot{R}_{-80} = \dot{R}_{A.L.T.}$$
$$V_{-80} = V_{A.L.T.}$$

these expressions can be equated, e.g., equating the pitch accelerations:

$$\dot{Q}_{-80} = \left(\frac{q_o S \bar{c}}{I_{YY}}\right)_{-80} \begin{bmatrix} (C_{m_{\Delta T}} \cdot \Delta T)_{-80} + (C_{m_\alpha})_{-80} \cdot \Delta\alpha \\ + (C_{m_{\dot\alpha}})_{-80} \cdot \dot\alpha + (C_{m_Q})_{-80} \cdot Q \\ + (C_{m_{\Delta V}})_{-80} \cdot \Delta V + (C_{m_{\delta e}} \cdot \delta e)_{-80} \\ + (C_{m_{\delta ab}} \cdot \delta_{ab})_{-80} \end{bmatrix} = \left(\frac{q_o S \bar{c}}{I_{YY}}\right)_{A.L.T.} \begin{bmatrix} (C_{m_{\Delta T}} \cdot \Delta T)_{A.L.T.} + (C_{m_\alpha})_{A.L.T.} \cdot \Delta\alpha \\ + (C_{m_{\dot\alpha}})_{A.L.T.} \cdot \dot\alpha + (C_{m_Q})_{A.L.T.} \cdot Q \\ + (C_{m_{\Delta V}})_{A.L.T.} \cdot \Delta V + (C_{m_{\delta E}} \cdot \delta_E)_{A.L.T.} \end{bmatrix} = \dot{Q}_{A.L.T.}$$

From the example given it can be seen that these expressions contain a mixture of control derivative and stability derivative terms. The aerodynamic variables in the stability terms ($\Delta\alpha$, Q, ΔV, etc., shown outside the brackets) are identical for both the -80 and the A.L.T. sides of the equation. The control variables (δe, δE etc., shown inside the brackets) are separate and distinct.

2.1 **BASIC THEORY (Continued)**

d These expressions can now be solved for the control variable appropriate to the axis being considered. Thus, for the example given above, the correct pitch acceleration is maintained by modulating the 367-80 elevator, so the equation can be rewritten as follows:

$$\delta_{e_{-80}} = \frac{K(C_{m_{\delta_E}})_{A.L.T.}}{(C_{m_{\delta_e}})_{-80}} \cdot \delta_E + \frac{K(C_{m_{\Delta T}} \cdot \Delta T)_{A.L.T.}}{(C_{m_{\delta_e}})_{-80}} - \frac{(C_{m_{\Delta T}} \cdot \Delta T)_{-80}}{(C_{m_{\delta_e}})_{-80}}$$

$$- \frac{(C_{m_{\delta_{ab}}} \cdot \delta_{ab})_{-80}}{(C_{m_{\delta_e}})_{-80}} + \frac{K(C_{m_\alpha})_{A.L.T.} - (C_{m_\alpha})_{-80}}{(C_{m_{\delta_e}})_{-80}} \cdot \Delta\alpha$$

$$+ \frac{K(C_{m_{\dot\alpha}})_{A.L.T.} - (C_{m_{\dot\alpha}})_{-80}}{(C_{m_{\delta_e}})_{-80}} \cdot \dot\alpha + \frac{K(C_{m_Q})_{A.L.T.} - (C_{m_Q})_{-80}}{(C_{m_{\delta_e}})_{-80}} \cdot Q$$

$$+ \frac{K(C_{m_{\Delta V}})_{A.L.T.} - (C_{m_{\Delta V}})_{-80}}{(C_{m_{\delta_e}})_{-80}} \cdot \Delta V \quad , \text{ where } K = \frac{\left(\frac{q_o S \bar{c}}{I_{YY}}\right)_{A.L.T.}}{\left(\frac{q_o S \bar{c}}{I_{YY}}\right)_{-80}}$$

This equation expresses the 367-80 elevator displacement (from trim position) as a function of simulated A.L.T. elevator input, A.L.T. and -80 thrust levels, -80 airbrake position, and aerodynamic variables, such that the 367-80 airplane will behave in pitch like the simulated A.L.T.

Similar expressions can be derived for the 367-80 rudder, wheel, thrust and airbrake commands.

For the full equations and derivations, see Appendix A.

e. The correct numerical values for the derivatives can now be inserted into these expressions, resulting in a set of equations which, when properly scaled, can be mechanized on the SD/80 computer using only amplifiers and potentiometers. The outputs of these amplifiers are then used as command signals to the 367-80 control surfaces to produce the required simulation.

2.2 COMPUTER MECHANIZATION (See Appendix A for basic computer diagram)

2.2.1 Patchboards

One patchboard was used for the basic Ames large transport configuration and another board, called the "-80 Checkout Board" was used to obtain in-flight information on the 367-80 control and stability derivatives.

The A.L.T. simulation board contained the following sections:

367-80 Model

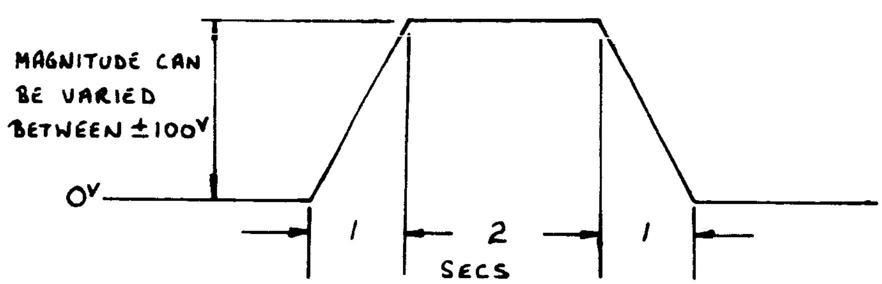
This was a linearized six-degree-of-freedom representation of the 367-80 airplane in the configuration that was set up for simulating the A.L.T.

A.L.T. Matrix

The A.L.T. Matrix was a network of amplifiers and potentiometers, derived from the equations described in Section 2.1, which generated the commands to the 367-80 control surfaces, as a result of control inputs from the Evaluation Pilot and aerodynamic feedback from the airplane sensors.

Pulse Circuit

The pulse circuit was initiated with a toggle switch and produced a pulse of the shape shown below:



The pulse circuit was used as a standard forcing function and could be applied as an elevator, rudder or wheel command either in the air or during ground checkout. A separate circuit produced a step function which could be applied as a thrust command.

Synchronizing Circuits

The synchronizing circuits were all similar and consisted basically of a chain of amplifiers whose output was integrated and used as negative feedback at the input of the chain.

If the simulator was selected but not engaged, the integrators were allowed to integrate, the effect being to keep the output of the circuit at zero. When the simulation was engaged, the integrators were put into the "hold" condition and the outputs of the circuits became difference values.

Three of the synchronizing circuits were used for converting the values of angle-of-attack (α), airspeed (V) and thrust reverser clamshell door position (δ_{CLAM}) to incremental variations $\Delta\alpha$, ΔV, and δ_{CLAM}, respectively, about the trim values.

In addition, the $\Delta\alpha$ circuit had provisions for compensating for the nose boom position, and the δ_{CLAM} circuit contained a one second time constant. The fourth synchronizing circuit was part of the thrust servo loop and was not an inherent part of the simulation.

$\dot{\alpha}$ and $\dot{\beta}$ Generating Circuits

Since neither $\dot{\alpha}$ nor $\dot{\beta}$ was directly available as the output of a sensor these signals were generated in the computer.

$\dot{\alpha}$ was obtained by a pseudo-differentiation of $\Delta\alpha$, and $\dot{\beta}$ from a combination of roll angle and yaw rate, $\left(\dot{\beta} = g\phi/V_o - R\right)$.

Control Input Circuits

These circuits provided the ability to apply either the Evaluation Pilot's command inputs from the instrumented controls, or the standard pulse from the pulse circuit, to the airplane.

Function Generators

Two diode function generators were used to compensate for the basic 367-80 nonlinear characteristics of pitching moment due to thrust changes and pitching moment due to air brakes.

Interlock Circuits

The interlock circuits made it impossible to engage the simulation unless all the cables were correctly installed. In addition, one of the interlock circuits determined which elevator PCU (left or right) was to be used as the master (see 2.4.1).

Configuration Selection Circuits

The variations from the basic configuration were achieved by changing the gains of various inputs to the A.L.T. Matrix. This was done partly by changing potentiometer settings and partly by switching in additional amplifiers and potentiometers depending on the particular variation required.

An external switch box containing four double-pole, double-throw switches was used for this purpose. The details of the changes needed for the various variations are given in Appendix B.

2.2.2 Interconnections Between the SD/80 Computer and Other Equipment

The SD/80 Computer had nine cable connections on the back side. Two of these, J104 and J105 were for remote mode-selection control of the computer and connected to the Interface.

The next six, J1 through J6, had the following functions:

J2 - Provided control command inputs to the -80 model and aerodynamic parameter outputs from the -80 analog model

J4 - Provided aerodynamic and control inputs to the miscellaneous circuits listed in 2.3.1.6 and also the command outputs from the A.L.T. Matrix amplifiers to the -80 airplane control surfaces

J3 - Provided connections between the various parameters being monitored and the in-flight C.E.C. oscillograph.

J5 - Provided "simulation engaged" signals for the synchronizing circuits and the System Engaged Light.

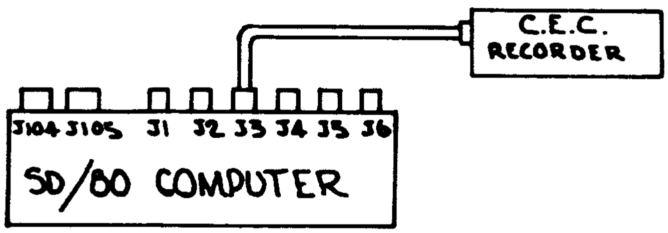
J1 - Provided engaged signal to the synchronizing circuits in ground checkout operation.

J6 - Spare

The ninth connector was for the main a.c. power supply.

The interconnecting cables could be hooked up in a number of different ways to produce different conditions.

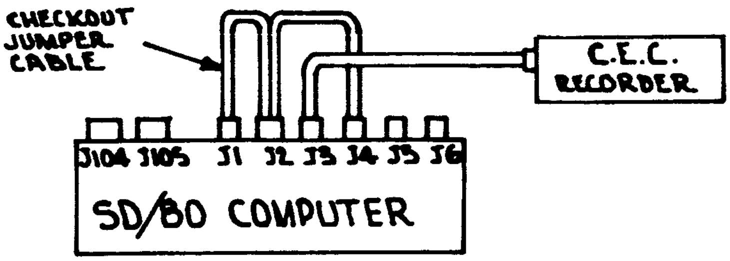
a. -80 Analog simulation ground check.



With only the connection as shown to the recorder, the -80 analog model could be used by itself and the pulse circuit output plugged directly into the appropriate command channel δ_e, δ_r , etc.

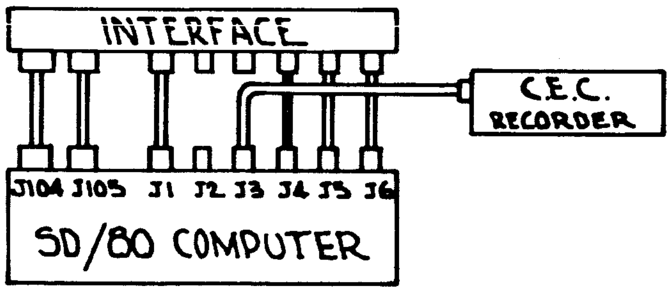
2.2.2 Interconnections Between Computer and Other Equipment (Continued)

b. A.L.T. Analog Simulation Ground Check:



With J1 and J4 connected to J2 by the "Checkout Jumper Cable" the A.L.T. Matrix was connected to the -80 analog model. In this condition the combined effect was that of an analog model of the A.L.T. configuration. It should be noted that if the A.L.T. Matrix gains were properly calculated then the same A.L.T. could be simulated with any values for the -80 derivatives. The Pulse Circuit was used to provide control inputs to the A.L.T. simulation δ_E , δ_R , etc.

c. In-flight A.L.T. Simulation:



With J104, J105, J1, J4, J5 and J6 connected to the correct Interface connections the A.L.T. Matrix was connected, through the Interface to the 367-80 control systems. Now, if the basic 367-80 airplane characteristics were identical to those mechanized in the -80 analog model then the airplane would respond, in the air, in the same manner as the A.L.T. model did during ground checkout.

2.3 AIRPLANE CONTROL SERVO SYSTEMS

Figures 16 through 20 show block diagrams of the five primary control systems used in the SST simulation.

2.3.1 Elevator Control System (Figure 16)

The elevator system had two parallel type actuators, right hand and left hand, in which the feedback linkage moved the Safety Pilot's column. The two actuators had different authority limits and either could be selected as the master control and the other automatically slaved to it.

The motion of the Safety Pilot's column was transmitted through a system of cables and pulleys to provide a mechanical input to the control valve that controlled the actuator which moved the elevator.

The position transducer on the Evaluation Pilot's column produced an electrical signal (δcol) that went to the computer. This signal was modified in the computer to provide the correct gain and summed with any contributions from the thrust command, air brake command, angle-of-attack, pitch rate, etc., to form an elevator command (δ_{e_c}). When the simulation was engaged, this signal was allowed to operate either the right hand or left hand transfer valve, whichever had been selected, and the resulting motion of the modulating piston operated the control valve of the actuator, causing the elevator to move.

2.3.2 Thrust Control System (Fig. 17)

The thrust reverser clamshell doors were moved by actuators, the control valves of which were supplied with mechanical inputs from the thrust reverser levers. If the simulation was not engaged the doors could be moved independently by moving the levers singly. However, as soon as the simulation was engaged the four levers were clamped together by an electro-mechanical clutch and moved as a unit by the thrust control servo. The transducer on the fake throttle produced an electrical signal (δ_{TH}) which went to the computer. Here it was modified to provide the correct gain and summed with any contributions from angle-of-attack, airspeed, air brake command, etc. to produce a thrust command (δth_c). This signal operated the electro-mechanical servo through the coupler.

2.3.3 Lateral Control System (Figure 18)

Lateral control of the airplane was obtained by differentially operating the ailerons and spoiler panels.

Moving the Safety Pilot's wheel put a mechanical input through the summing linkage into the control valve of the lateral control power unit and moved the actuator. The output of the actuator went to the spoiler mixer where it was summed with the mechanical output from the speed brake handle. The mechanical output of the spoiler mixer was connected to the Hydomat units which drove the spoiler panels.

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2.3.3 Lateral Control System (Figure 18) (Continued)

The transducer on the Evaluation Pilot's wheel produced a signal (δw) which went to the SD/80 computer. Here it was modified to provide the correct gain and summed with any contributions from side-slip angle, yaw rate, roll rate, etc., to produce a wheel command ($\delta \omega_c$).

In simulation mode this command operated the transfer valve on the lateral control power unit. Since this power unit was a parallel-type actuator its output fed back to move the Safety Pilot's wheel.

2.3.4 Rudder Control System (Fig. 19)

The Safety Pilot's and Evaluation Pilot's rudder pedals were coupled and provided a mechanical input through the summing linkage to the control valve on the rudder actuator. The output of the actuator moved the rudder and was also fed back to the summing linkage. In addition, the position transducer on the Evaluation Pilot's rudder pedals put out an electrical signal (δ_R) which went to the SD/80 computer. This signal was operated upon in the computer to provide the correct gain, and was summed together with any contributions from the wheel command, side slip angle, side slip rate, etc. to form the rudder command (δr_c). If the simulator was engaged, then this signal was allowed to operate the transfer valve causing the modulating piston to provide an additional input to the control valve. The modulating piston transducer provided rate feedback to the rudder command servo amplifier in the Interface.

2.3.5 Lift Control System (Fig. 20)

Lift control during the simulation was obtained by modulating the spoiler panels on the upper wing surface. The positions of the spoilers are shown in Fig. 14 where they are numbered for clarity. For the simulations covered in this document, spoilers 1, 5A, 6A and 10 were not used. The spoilers were operated by electro-hydraulic Hydomat units. Spoilers #4, 5, 6 and 7 each had a separate Hydomat Unit, but spoilers #8 and 9 were both driven by one unit and so were #2 and 3. Spoilers #2, 3, 8 and 9 are referred to as the outboard spoilers and #4, 5, 6 and 7 as the inboard spoilers.

The lift modulating signals (δab_c) were produced in the computer. Because of buffeting at high spoiler angles the inboard spoilers were electrically limited to + 10 degrees. Up to this point the spoilers all moved together but above 10 degrees the gain on the outboard spoilers was doubled, by a circuit in the computer, to keep the value of $C_{L_{\delta ab}}$ constant.

The mechanical input shown in Fig. 20 came from the spoiler mixer (See Fig. 18) and combined the initial trim setting from the speed brake handle and the lateral control input from the lateral control power unit.

2.4 OPERATING PROCEDURES

2.4.1 Establishing the Basic 367-80 Characteristics

The first step in setting up a simulation was to establish a 367-80 configuration suitable for the airplane to be simulated. The factors to be considered were:

- The trimmed level flight airspeed of the 367-80 must match that required for the simulated airplane. This affected the trim thrust and flap setting.

  The 367-80 was equipped with a blown flap system using engine bleed air which could be used to increase the value of C_L. For the configurations described in this document it was not necessary to use this feature.

- The entire simulation was flown with the 367-80 engines at constant throttle settings and thrust and drag changes were achieved by modulating the thrust reverser positions. This means that the clamshell doors had to be set initially at some partially closed position which allowed sufficient range of movement of opening and closing without limiting the simulation.

  This initial angle also had to be coordinated with the constant engine output to achieve the trimmed airspeed mentioned above.

- The changes in lift coefficient during simulation were achieved by modulating the spoiler panels on the upper wing surface. These therefore had to be set up at some angle for the trim condition so that they could be modulated in both directions during simulation.

- All simulation was performed with the landing gear down so that the approach could be continued down to touchdown.

The final configuration adopted for the 367-80 for simulating the basic A.L.T. was:

367-80 CONFIGURATION AT TRIM

Airspeed	Angle of Attack of Wing	Engine Settings (N2)	Clamshell Doors	Flaps	Spoilers	Gear
117 Knots	8.5°	96%	30°	30°	6°Up	Down

2.4.1 Establishing the Basic 367-80 Characteristics (Continued)

These were the nominal settings. The aircraft was trimmed in level flight by the Safety Pilot at the desired airspeed and angle-of-attack, by use of the moveable stabilizer and small throttle adjustments, prior to engagement of the simulation. Once set, the stabilizer and throttles were not moved during simulation, as all pitch and thrust changes were made with the elevators and thrust reversers.

- Flight Testing the Basic 367-80 Configuration

Once the trim configuration had been tentatively determined, the airplane was flight tested in order to obtain the following information:

a. Confirmation and adjustment, if necessary, of the basic trim configuration (proper stall margin and body landing attitude).

b. Documentation of the airplane characteristics. This consisted of a series of maneuvers designed to facilitate the calculation of the airplane stability and control derivatives so that an accurate analog model of the 367-80 could be mechanized on a computer.

c. Recording of airplane responses to standard pulse inputs for confirmation and adjustment of the analog model. These recordings were used in the "overlay" technique described in Section 2.5.

The standard pulse inputs were performed using the -80 checkout board described below.

The -80 Checkout Board was a special patchboard used on the Systron Donner SD/80 Airborne Computer which contained: A six-degree-of-freedom linearized analog model of the basic 367-80; a special check pulse circuit (see 2.2.1); and provisions for connecting the Evaluation Pilot's controls through the SD/80 computer and the Interface to the airplane electro-hydraulic servo systems. The gains in the computer were selected so that the control derivatives remained identical to those of the basic airplane. Thus, the airplane characteristics were the same whether it was flown from the left-hand seat with the normal controls, or from the right-hand seat through the fly-by-wire system.

There was also provision for introducing the standard pulse into the system to simulate column, wheel, rudder or thrust commands. It should be noted that the input to the thrust was actually a step but for simplicity of writing it will be referred to as a standard pulse.

2.4.1 (Continued)

The aircraft checkout, using standard pulses, was as follows: The airplane was first trimmed in level flight at the correct airspeed and angle-of-attack by the Safety Pilot from the left-hand seat. When this condition had been achieved the simulation was engaged and the Evaluation Pilot then retrimmed the airplane, if necessary, to remove the effect of any engagement transients. When he was satisfied that the airplane was trimmed, he called for a standard pulse input from the computer. The input had already been selected to be applied to the elevator, wheel, rudder or thrust reversers. The pulse was initiated by operating a toggle switch.

The airplane response to this input was monitored by recording the following parameters on a CEC light beam oscillograph.

CHANNEL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VARIABLE	δ_{ab}	P	Q	-R	ϕ	ΔV	$\Delta\alpha$	$-\beta$	$-\dot{\beta}$	δa_c	$\delta\omega_c$	δr_c	PULSE	δth_c	δ_{CLAM}

If the input was an elevator or thrust command, the Evaluation Pilot would keep the wings level, being very careful not to initiate any longitudinal disturbances. Similarly during wheel and rudder pulses the Evaluation Pilot would maintain essentially the same pitch attitude without restraining the lateral degrees of freedom.

This technique enabled "hands-off" data to be obtained without the confusing cross-coupling effects between the longitudinal and lateral-directional axes.

The resulting airplane motion was allowed to continue sufficiently long to obtain several cycles of the phugoid mode for elevator inputs, or the dutch roll mode for rudder and wheel inputs, or until the airspeed changed by 10 knots for the thrust steps.

The oscillograph records obtained during these tests were used to check the analog simulation of the basic 367-80.

- Ground Support Programs (Basic 367-80 Only)

  As soon as sufficient information had been received on the basic 367-80 control and stability derivatives from the Aerodynamics Group, the gains were calculated for the analog simulation of the basic airplane and the model was set up on the -80 checkout board.

  The same standard pulse inputs that were applied to the actual airplane in-flight were applied to the analog model on the ground.

  The response of the model was recorded using the same oscillograph to record the same variables with the same scalings.

- Ground Support Programs (Basic 367-80 Only) (Continued)

The accuracy of the simulation and hence the accuracy of the derivatives used were checked by directly comparing the results.

This was done partly by measurement and partly by comparing the various mode shapes by directly laying the flight test results over the ground test results.

The measured values were:

- o Phugoid period and damping ratio
- o Dutch roll period and damping ratio
- o Roll angle to side-slip-angle ratio
- o Spiral time constant (time to half amplitude).

The other characteristics, which did not lend themselves to direct measurement were:

- o Longitudinal short-period characteristics
- o Initial lateral-directional response to a control input
- o Pitching moment due to thrust changes.

These were compared by direct overlay.

By making adjustments to the appropriate gains on the computer simulation, the match between the flight and ground tests could be improved and the values of the basic 367-80 derivatives refined by calculating back from the corrected gain settings. This part of the program was backed up by an additional ground based computer simulation of the basic airplane as a check on the -80 check-out board model. It should be noted that this did not confirm the validity of the model but only served to demonstrate that the simulation, as patched-up, was functioning properly.

2.4.2 Setting Up the A.L.T. Simulation

Once the control and stability derivatives of the basic 367-80 had been reasonably well established the calculations for the A.L.T. matrix were performed. These calculations were based on the theory outlined in Section 2.1, and the full equations are given in Appendix A.

2.4.2 (Continued)

The calculations for the program covered in this document were initially done by hand using the tabulated forms shown in Appendix A, Pages A1 to A32, etc., but later a digital program was set up on an IBM 7090 computer to produce this information. The program was written in a Boeing-originated computer language called BLITZ. (Further information on this language can be obtained from Boeing Document D2-36341-1, "The BLITZ User's Manual." See Ref. D.)

The A.L.T. matrix was then patched up on the A.L.T. patchboard and the correct gains set in.

Once the A.L.T. patchboard was completed, a ground simulation of the A.L.T. configuration was produced by connecting the checkout jumper cable as shown in Section 2.2.2.b.

The end result of combining the basic 367-80 analog model with the A.L.T. matrix was to produce a simulation identical to that which would result from a straight-forward simulation using the A.L.T. derivatives alone.

It should be noted here that, as long as the A.L.T. matrix calculations were correct, the basic -80 derivatives which were used in the calculations were irrelevant, as far as the ability to produce an analog simulation of the A.L.T. is concerned. In other words, a ground simulation of the particular A.L.T. could be obtained by using an analog simulation of a Piper Cub, for example, provided the A.L.T. matrix calculations were based on the Piper Cub derivatives. Naturally this would vastly affect the results obtained in the air when the real 367-80 characteristics were substituted for the analog model.

The output of the pulse circuit was then applied to the simulation to produce the responses of the A.L.T. to standard pulse inputs. The technique was similar to that described for testing the 367-80 analog model alone in Section 2.4.1 except that the pulses were applied at different terminals since it was commands to the A.L.T. elevator and rudder etc., that were required and not commands to the 367-80 elevator and rudder.

As before, the variables listed in Section 2.4.1 were recorded on the CEC Recorder, the results being checked against the results of the digital program described in the next section.

It was desired to have a completely independent means of checking the accuracy of both the analog simulation of the A.L.T. on the ground and the flight test results obtained in the air.

For this reason it was decided to utilize a digital computer to obtain data on the dynamic response of the basic A.L.T and variations.

2.4.2 (Continued)

The Boeing TL99 digital program was used to support this phase of the work.

This program was capable of solving simultaneous non-linear differential equations and lent itself to the solution of the equations of motion of an airplane. The equations could be expressed in a block diagram form that was very similar to the computer diagram for an analog simulation of an airplane.

This block diagram was easily converted into a deck of punched cards for input to the digital computer.

Disturbing inputs, identical to the standard pulses, were introduced into the program and the resulting airplane responses became available as a time history of the aerodynamic variables whose values were tabulated at half-second intervals. The program was supplied with the calculated control and stability derivatives of the proposed A.L.T configurations and the resulting tabulated data plotted on transparent mylar to the same vertical and horizontal scales as the outputs of the CEC Recorder. The master plots could be directly overlaid on the ground and flight recordings from the CEC Recorder to determine the accuracy of the simulation.

Figures 21 and 22 show prints from two typical master overlays obtained by this program with the flight data from the CEC Recorder for the same maneuvers superimposed on the master traces.

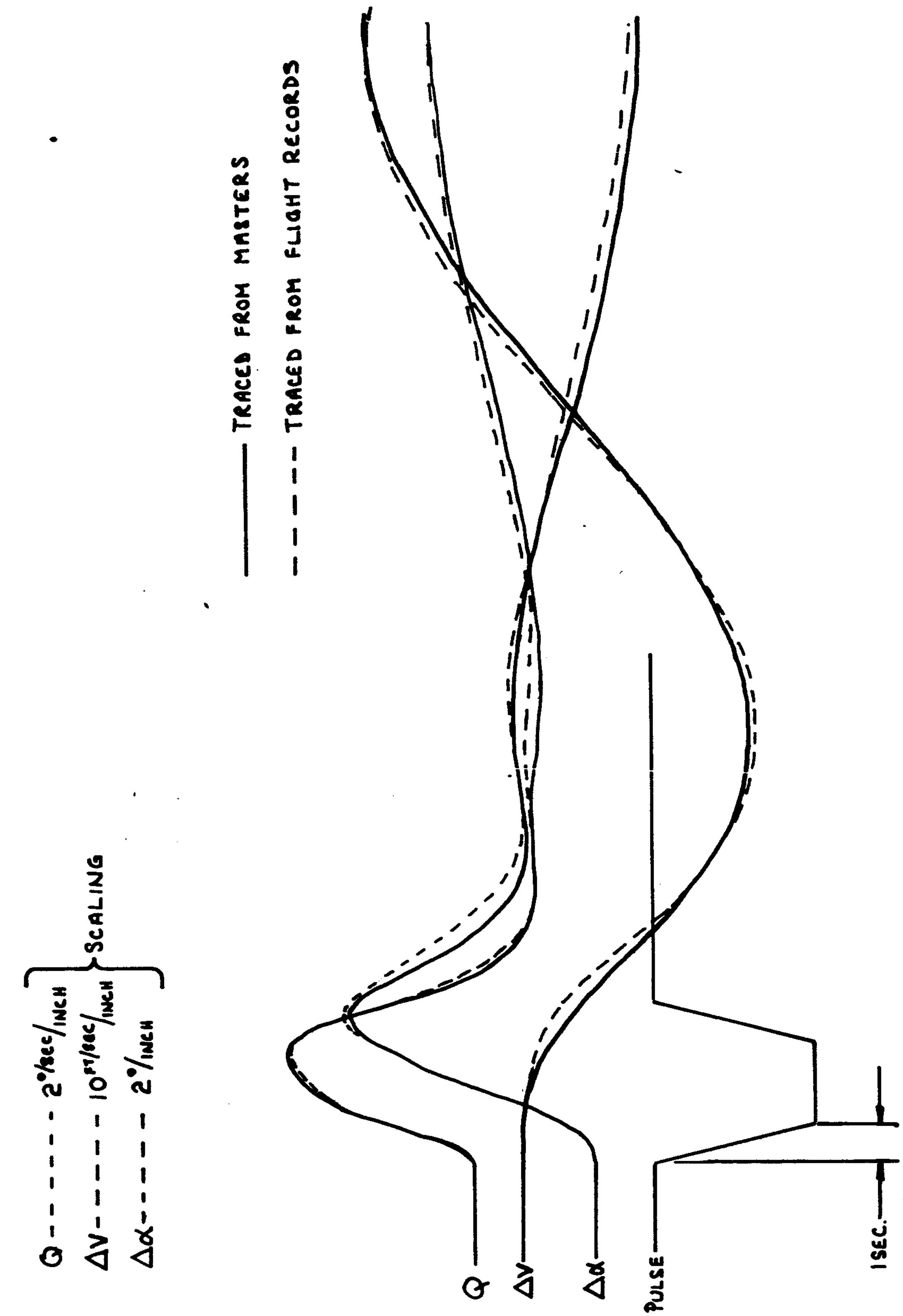
The flight tests of the A.L.T. simulation were carried out with the SD/80 computer-to-interface cable connections as shown in Section 2.2.2.c, Page 38. The procedure used for checking the accuracy of the simulation was identical to that already described in checking out a standard pulse.

Immediately after each maneuver the in-flight recordings were checked to determine the accuracy of the simulation by direct measurement of phugoid and dutch roll periods, damping ratios, etc., and by overlaying the master traces described in the above section.

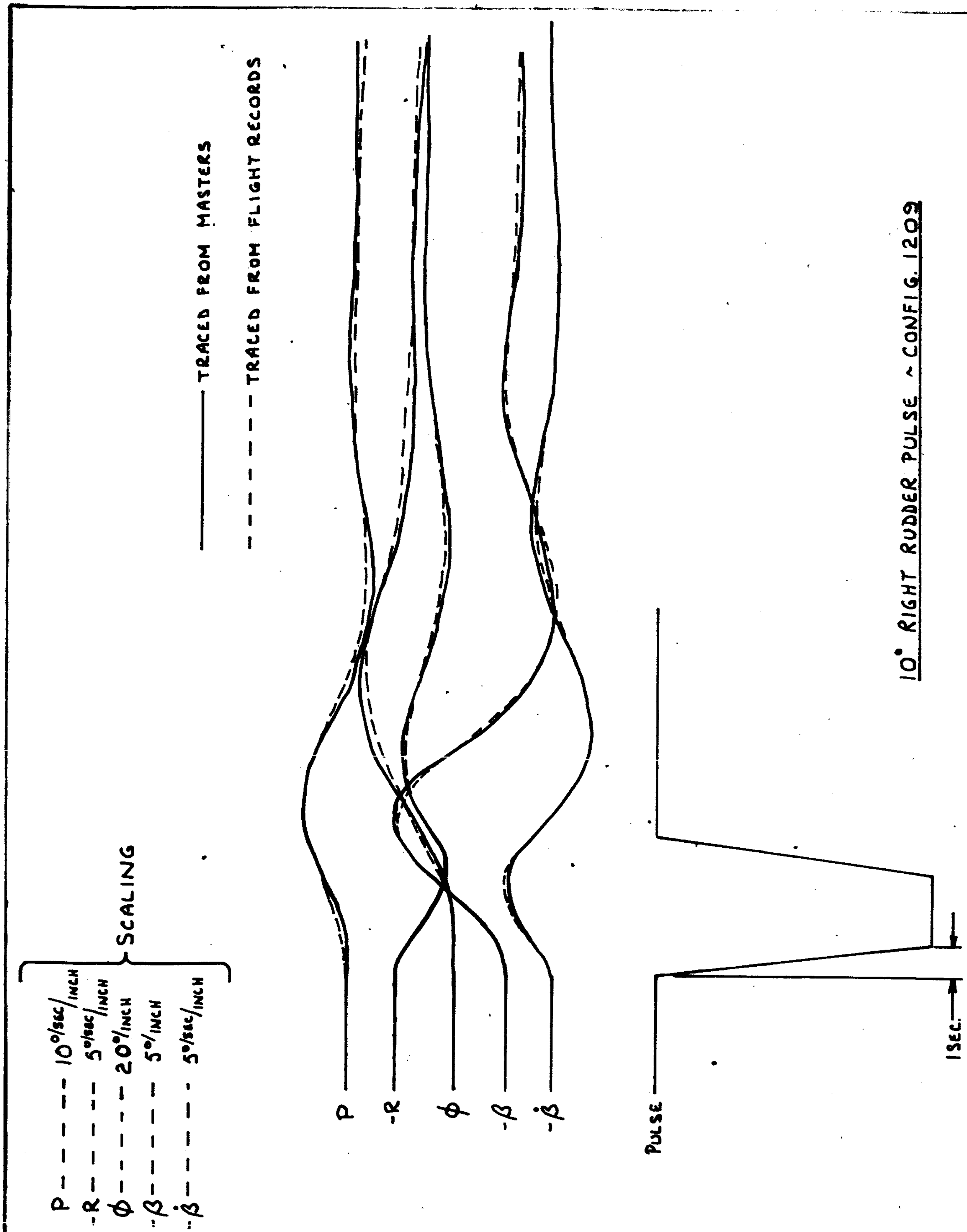
In the initial or checkout phase of the flight test program, it was necessary to "fine tune" the simulation to improve its accuracy. This was done by changing the gains of the A.L.T. matrix and repeating the check pulses as required to improve the match between the flight and ground test results.

It should be noted that, since the A.L.T. derivatives were fixed, any changes made to the gains of the A.L.T. matrix during the checkout phase were equivalent to changing the basic 367-80 derivatives.

The new 367-80 derivatives were obtained by calculating backwards from the A.L.T. matrix gains and then cranked into the analog simulation of the basic 367-80.



5° NOSE UP ELEVATOR PULSE ~ CONFIG. 101A



10° RIGHT RUDDER PULSE ~ CONFIG. 1209

FIG. 22

2.4.2 (Continued)

Once the match was judged to be sufficiently good by the test engineer, the simulation was frozen and the test program proceeded to the documentation and pilot evaluation phases. From this point, the only changes made on the computer were those necessary to introduce the variations to the basic configuration which were to be tested, and the periodic adjustment of a special potentiometer which was varied according to the test altitude and outside air temperature to compensate for the variation in engine thrust.

During the documentation and evaluation phases, the airplane was subjected to the Standard Pulses at the beginning of each flight, and the results were examined to confirm that the simulation was still valid, before proceeding with the tests.

2.4.3 Pre-flight Checkout

The pre-flight checkout consisted of a series of ground tests that were performed as a standard procedure prior to each simulation flight.

Power was applied to the airplane and the system allowed to warm-up for at least 30 minutes before starting the pre-flight checkout.

The pre-flight checks were:

a. Computer voltage and amplifier balance checks.

   The computer power supplies were checked for the correct voltage and the amplifiers checked for balance and adjusted if necessary.

b. Potentiometer Setting Checks.

   All the potentiometers that were used in the simulation were checked for the correct settings by nulling them against the reference potentiometer.

c. Standard Pulse Checks.

   The computer cables were connected for A.L.T. ground checkout (See 2.2.2.b Page 34) and the standard pulses applied to the elevator, thrust, wheel and rudder inputs. The resulting traces from the CEC recorder were checked against the A.L.T. masters to confirm that the computer was functioning properly.

d. Instrumentation Zeros.

   At this point the command outputs from the computer were set to zero by shorting the outputs of the relevant amplifiers to the summing junctions. This was done so that the Instrumentation Engineer could record the zero references.

2.4.3 (Continued)

e. Simulation Logic Checks.

The logic circuitry was checked to ensure that the Simulation "SELECT," "ENGAGE," "RESET" controls, disconnect buttons and error detectors were working properly.

f. System Functional ("Wiggle Tests").

These tests were to ensure, as far as was possible, that the entire system was working as programmed. The computer cables were connected for in-flight simulation (see 2.2.2.c, Page 38).

To perform the tests, the airplane hydraulics were turned on and hydraulic power supplied to all the actuators; the spoiler panels set to 6°; and the clamshell doors set to 30°. The simulation was then engaged and the following tests performed:

TEST	CHECK THAT (NOTE: The values depend on the A.L.T. Configuration and so are not quoted.)
Move Evaluation Pilot's column fully forward and aft.	Safety Pilot's wheel and -80 elevator move the correct amount and direction. Computer elevator command output is correct.
Move the Evaluation Pilot's wheel right and left.	Safety Pilot's wheel and the -80 ailerons and spoiler panels move the correct amount and direction. Computer wheel command output is correct.
Move the Evaluation Pilot's rudder pedals right and left.	The -80 rudder moves the correct amount and direction. Computer rudder command output is correct.
Move the Fake Throttle forward and aft.	Clamshell doors and thrust reverser levers move the correct amount and direction. Computer thrust command output is correct.
Move nose boom vane $\pm\alpha$, keeping β at 0.	-80 elevators and spoilers move correct amount and direction. Computer output commands are correct.
Move nose boom vane $\pm\beta$, keeping α at 0.	-80 rudder and lateral controls move correct amount and direction. Computer output commands are correct.
Operate Evaluation Pilot's longitudinal trim control.	-80 Elevators move up and down the correct amount.
Unbolt rate gyros and move by hand. (Hydraulics OFF)	Computer signals from gyros are correct polarity.

2.5 SYSTEM HARDWARE DESCRIPTION

2.5.1 Cabin Controls

Figure 2 shows an overall picture of the airplane cabin. In addition to the normal airplane controls and instruments, the following are of special interest in the simulation:

The Evaluation Pilot's control column and wheel were not mechanically connected to the airplane control systems. Instead, stick and wheel position signals were obtained from potentiometers and these signals were fed through the interface to the SD/80 computer.

NOTE: The arms of the wheel were also instrumented with strain gauges, the outputs of which were averaged to give a measure of stick force. This signal was available at the computer and could be used as the Evaluation Pilot's input, but for the simulations covered in this document stick position was used.

Feel force for the Evaluation Pilot's wheel was supplied by a spring cartridge mounted on the column directly behind the wheel. The force gradient characteristics could be changed by changing the cartridge. The stick feel force was supplied by a hydraulic system which was controlled pneumatically from a pressurized nitrogen bottle. The control knob for changing the force gradient and the indicator for showing the stick force in lb/degree of stick movement can be seen at (K) in Figure 2 and also in the close-up picture, Figure 3.

The Evaluation Pilot's rudder pedals were connected mechanically to the Safety Pilot's and consequently move the 367-80 rudder through the normal control system. However, in addition, a potentiometer provided an electrical signal proportioned to pedal displacement which was used in the computer to modify the rudder during simulation.

The following descriptions all refer to the letters on Figure 2:

a. Fake Throttle Lever.

This lever was connected to a potentiometer which put out an electrical signal to the computer and provided the Evaluation Pilot with the means to make thrust changes. Figure 3 shows a close-up of the fake throttle lever and its calibrated scale.

b. Evaluation Pilot's Disconnect Button.

The Evaluation Pilot could disengage the simulation and return control to the Safety Pilot at any time by operating this button. If disconnect occurred, the two red blinking warning lights (N) came on and the "RESET" button on the control panel (Figure 3) had to be operated before the simulation could be re-engaged (see Section 2.5.1 h.).

2.5.1 Cabin Controls (Continued)

c. Evaluation Pilot's Longitudinal Trim Control.

This was a two position, center-off switch which supplied either ± 15 V to the computer, depending upon whether it was held in the nose-up or nose-down trim position. This voltage was integrated in the computer and the result applied as an elevator command to trim the airplane.

d. Signal Connector.

This connector carried the signals from the strain gages mentioned above.

e. Evaluation Pilot's Lateral Trim Control.

Lateral trim in simulation mode was obtained by a potentiometer which applied a bias voltage to the lateral control command signal. This signal did not go to the SD/80 computer but was added in the Interface.

f. Thrust Reverser Positioning Levers.

The standard thrust reverse levers were used to set the clamshell doors to their trim positions (approximately 30°). The clamshell door positions for the four engines were shown by the four indicators at (M).

g. Speed Brake Handle.

The normal speed brake positioning control was used to set the spoiler panels to their trim position (6° up). The position of spoiler panel No. 8 was monitored with a transducer and displayed on an indicator (L) mounted above the IRIG time display on the glareshield.

h. Simulation Control Panel.

This panel contained the controls with which the safety pilot selected the mode of operation. A close-up of this panel can be seen in Figure 4.

The selector buttons marked "YAW RATE," "YAW RATE & TCF," "RUD III," "AILERON" refer to various stability augmentation systems available on the basic 367-80 and are outside the scope of this document. The selector button marked "NORMAL" refers to a condition whereby the basic "367-80" could be flown by a "fly-by-wire" system from the right-hand seat and is also outside the scope of this document, although it resulted as a direct offshoot of this program. The controls that are directly concerned with the simulation are:

SIMULATION - when the Safety Pilot pushed this button, the simulation was selected but not engaged, and a blue light illuminated the left-hand section marked "SEL." The Safety Pilot selected this condition prior to

2.5.1.h (Continued)

trimming the airplane. In this condition the mode control logic in the Interface put the SD/80 computer into the "COMPUTE" mode (it was previously in "RESET") which allowed the synchronizing circuits for $\Delta\alpha$ and ΔV to start operating. The Evaluation Pilot's controls were still disconnected from the system. When the aircraft was trimmed the Safety Pilot pushed the "PUSH TO ENGAGE" button.

"PUSH TO ENGAGE" - This control engaged the simulation and activated the analog gates in the Interface allowing the command outputs from the SD/80 computer to be applied to the control surface actuators. Simultaneously the $\Delta\alpha$ and ΔV synchronizing circuits in the computer were put into the "HOLD" condition; the "ON" portion of the "SIMULATION" control button was illuminated with a green light and the "simulation engaged" light on the computer patchboard was turned on. The simulation could be disengaged by pulling up on the "PUSH TO ENGAGE" button but this feature was seldom used.

"RESET" - This control was used to reset the mode selection logic in the Interface if the simulation had been disengaged as a result of an error in the system or because the Evaluation Pilot had operated his disconnect button.

j. Safety Pilot's Disconnect Button.

By operating this control the Safety Pilot could disengage the simulation at any time and regain control of the airplane. The simulation mode changed from "ON" to "SELECTED."

k. Evaluation Pilot's Stick Feel Force Control and Indicator.

Described previously.

l. Spoiler Panel No. 8 Position Indicator.

Described previously.

m. Thrust Reverser Clamshell Door Position Indicators.

Described previously.

n. Simulation Disconnected Warning Lights.

These were two large red blinking warning lights that came on if the simulation was disengaged either by an error in the system or by the Evaluation Pilot's disconnect button. These lights did not go out until the Safety Pilot's Disconnect Button was operated.

o. Simulation Limits Warning Lights.

These five amber warning lights for the rudder, spoiler, elevator, lateral control and thrust servo systems indicated when the servo amplifier

2.5.1 o. (Continued)

error signal had been exceeding a predetermined threshold value for more than half a second. This did not result in an automatic disconnect but indicated that the accuracy of the simulation was in doubt.

p. Reference Airspeed Setting Indicator.

The airspeed signal to the computer was the difference between the value obtained from the Pitot-Static System and the value set into the reference airspeed indicator. The latter value was set to the normal trim speed, by means of the knob at the lower left corner of the indicator, to prevent over-loading of the ΔV synchronizing circuit.

2.5.2 Systron-Donner SD/80 Analog Computer

The Systron-Donner SD/80 computer used on this program was basically a production-line desk-top type computer (Figure 5, Page 16 shows the computer as it was mounted in the airplane). Certain modifications were made at the factory prior to shipment. These were:

a. The addition of special shock mounts designed for the vibration environment in the airplane.

b. The ruggedizing of the amplifier module mounting system.

c. The potting of the amplifier components on the printed circuit boards.

d. The addition of a heater and fan, controlled by a toggle switch so that the computer could be purged with warm air. This provision was added because of the possibility of moisture condensation in the computer when the airplane stood outside overnight.

e. The addition of warning lights to indicate an overtemperature condition. This provision was added because the computer was used on the ground at times when the airplane air-conditioning system was not operating.

f. Modification to the power supplies to enable the computer to be operated from a 400 cps supply instead of 60 cps.

The computer contained 84 solid state operational amplifiers which were mounted in pairs on removable modules directly behind the patchboard (see Figure 5, Page 16).

The modules contained additional components which determined the type of operation for which they could be used; i.e., summing amplifiers, inverting amplifiers, or integrators.

As used for this program the computer had 44 summers, 18 inverters and 22 integrators. In addition, there were 18 double-pole, double-throw relays mounted in pairs on 9 of the modules.

2.5.2 (Continued)

The computer had two moveable wings on which the controls were mounted. The left-hand wing contained: (Referring to Figure 5)

a. Fifteen diode function generators in removable modules mounted in a receptacle behind this panel.

b. The overheat warning lights and the heater toggle switch.

c. A voltmeter which could be used either as a direct reading instrument or as a nullmeter.

d. The address selector switches for monitoring the output of any particular amplifier or potentiometer on the panel meter.

e. The top six switches were for selecting one of six direct-reading panel meter scales (± 300V, ± 100V, + 30V, ± 10V, ± 3V, ± 1V) to 2% of full scale accuracy. The two botton switches selected either ± NULL for measuring any problem voltage with an accuracy of 0.01% of full scale by comparison with a reference voltage selected by the reference potentiometer.

f. Four-digit reference potentiometer.

g. Panel containing operating controls and indicators. These are: Four push-button/indicators for selecting HOLD, COMPUTE, RESET and REP-OP Modes.

- Time scale control (not used in this simulation).
- Slave switch for selecting either local control at the computer or external control through the Interface.
- Power-on switch.
- Indication for oven-power, amplifier overload, etc.

h. Five single-pole, double-throw toggle switches with center-off position, and five potentiometers for gain adjustment.

The right-hand wing contained 120 more potentiometers for gain adjustment.

2.5.3 Interface

The Interface is shown in Figure 6 as it was mounted in the airplane. Some of the equipment in the interface was concerned with basic 367-80 stability augmentation systems and is outside the scope of this document. A full description of the Interface can be obtained from Boeing Document D6-19857 "Variable Stability Interface Installation in 367-80 Airplane." (Reference E). The equipment associated with the variable stability system is, referring to Figure 6:

a. Section containing the servo amplifiers and associated electronics for the spoiler panel servos.

2.5.3 (Continued)

b. Controls for monitoring the outputs of the various amplifiers in the Interface, and for selecting the panel meter full scale deflection values.

c. This panel contains duplicate simulation mode controls, similar to the controls in the cabin, and error-indicating lights.

d. Lateral control servo amplifiers and associated electronics.

e. Elevator servo amplifiers and associated electronics.

f. Rudder and aileron servo amplifiers and associated electronics.

g. Isolation networks, demodulation, etc.

h. This section contains the mode control logic digital circuits.

i. Isolation networks.

j. Power distribution and control circuits.

2.5.4 Airplane Sensors

The following sensors were used to provide aerodynamic data to the computer.

- Angle-of-Attack and Sideslip Sensor ($\alpha\beta$ Vane)

  Figure 7 shows the $\alpha\beta$ vane as it was mounted on the nose boom. This vane was specially designed by Giannini to have a very good low frequency response characteristic and a natural frequency of about 23 cps. The vane was supported on two gimballs whose angles were monitored by low friction potentiometers. The tip of the beam was bent down so that high angles of attack, up to 30° could be accommodated without reaching the mechanical limit of the vane.

- Rate Gyros

  Pitch, roll and yaw rate information was obtained from two rate gyro packages mounted in the lower 41 section of the airplane. The roll-rate gyro was the smaller package on the right in Figure 8. The larger package was a 3-axis gyro which was used for pitch and yaw rates.

- Vertical Gyro

  Not shown on Figure 8 but directly below the rate gyros was a vertical gyro which provided roll angle information.

- Airspeed Sensor

  The airspeed signal was obtained from the pilot's pitot static system, the output of which fed the airspeed synchro.

2.5.4 (Continued)

The final output of the airspeed system that went to the computer was a voltage that indicated the incremental difference of the airspeed above or below the value set on the pilot's reference airspeed instrument.

2.6 AMES LARGE TRANSPORT BASIC CONFIGURATION AND VARIATIONS SIMULATED

A basic assumption of the simulation was that no cross-coupling existed between the lateral-directional and longitudinal axes and that it was possible to vary the lateral and longitudinal characteristics of the simulated airplane independently.

The various configurations, lateral and longitudinal, were given configuration numbers for identification purposes. These configuration numbers and the significant changes from the basic configuration are listed in the following tables. In each case, the first configuration listed is the basic and corresponds to the full set of derivatives for the Ames Large Transport given in the description sheet in Appendix A, Sheet A30. The modification to the computer diagram required to achieve the variations and the corresponding calculations and BLITZ Program outputs are given in Appendix B.

Table I Lateral-Directional Configurations

CONFIG. NO.	REQUIRED INDEPENDENT CHARACTERISTICS					DEPENDENT CHARACTERISTICS	
	MAX. WHEEL ANGLE (δ_w max.) (DEGREES)	MAX. WHEEL RATE ($\dot{\delta}_w$ max.) (DEG./SEC.)	WHEEL SENSITIVITY $C_{l_{\delta w}}$ /RAD.	ROLL TIME CONST. τ (SEC.)	ROLL TIME CONST. C_{l_p} /RAD./SEC	Max. Steady State Roll Rate (P_{ss} max) DEG./SEC.	Max. Roll Acceler. ($\dot{\phi}$ max.) DEG./SEC.^{2}
1209 BASIC	75	375	.0973	1.14	-.2442	26.2*	14.3*
1203A	30	150	.1457	1.14	-.2442	26.2*	14.3*
1207A	30	150	.0912	1.14	-.2442	9.75	8.6
1235	50	250	.0915	.6	-.510	8.6	14.3*
1237	50	66	.0915	1.14	-.2442	16.0	14.3*

*These values were limited by basic 367-80 characteristics.

2.6 (Continued)

Table II Longitudinal Configurations

Config. No.	Required Characteristics					Corresponding Derivatives	
	Short Period		Lift Coeff. Due to Elevator	Elevator to Column Gearing	Elevator Power		
	Damping Ratio ζ	Frequency ω_n	$C_{L_{\delta_E}}$	$\delta_E/\delta_{COL.}$	$C_{m_{\delta_E}}$	C_{m_α}	C_{m_Q}
100 (Basic)	.71	.93	+.40	1.5	-1.56	-2.0	-2.4
101A	.71	.93	+.40	1.5	-2.3	-2.0	-2.4
105*	.71	.93	+.40	4.5	-1.56	-2.0	-2.4
105A	.71	.93	+.40	3.0	-2.3	-2.0	-2.4
151	.71	.93	-.40	1.5	-1.56	-2.0	-2.4
151B	.71	.93	-.40	1.5	-2.3	-2.0	-2.4
151C	.71	.93	.00	1.5	-2.3	-2.0	-2.4
151D	.71	.93	-.40	3.0	-2.3	-2.0	-2.4
158	.71	1.28	+.40	3.0	-1.56	-4.0	-4.8
158A	.71	1.28	+.40	3.0	-2.3	-4.0	-4.8
159	.87	1.08	+.40	1.5	-1.56	-2.0	-4.8
159A	.87	1.08	+.40	1.5	-2.3	-2.0	-4.8
159B	.87	1.08	+.40	3.0	-2.3	-2.0	-4.8
161	.96	.67	+.40	3.0	-1.56	-0.5	-2.4
161B	.96	.67	+.40	3.0	-2.3	-0.5	-2.4

3.0 PROBLEM AREAS

A certain number of problems were encountered in the program that are inherent to this type of simulation. They are briefly summarized below.

3.1 Derivatives

Because the simulation depended upon the calculated differences between the 367-80 derivatives and the simulated A.L.T. derivatives, it was more difficult to simulate airplanes that were radically different from the 367-80. This was particularly true of the variations which had a low value of C_{M_α}.

3.2 Linearized Equations

The simulation was based on linearized equations of motion and consequently any variables that were actually non-linear over the range of the simulation affected the accuracy of the simulation. This situation could be improved by using function generations for the most non-ninear variables provided, of course, that the functions could be accurately defined. In the simulation, function generators were used to compensate for the 367-80 pitching moments due to thrust and spoilers, which are both non-linear.

3.3 True Trim Condition

Since the simulation was based on perturbation equations and the variables were all incremental values about a trim condition it was extremely important that the trim condition be established as accurately as possible. Any variation from the true trim condition before the simulation was engaged affected the subsequent airplane behavior.

3.4 Turbulence

The effect of turbulence on the accuracy of the simulation was very marked. This was because the output of the $\alpha\beta$ vane fed directly into the computer and any output which was the result of a gust rather than a true change in the angle-of-attack of the wing produced an erroneous elevator command and affected the behavior of the airplane. To maintain the required confidence level in the results the flight testing was limited to conditions of zero to light turbulence.

REFERENCES

A. Boeing Document D6-19856. "367-80 Airplane Variable Stability Simulation System (NASA Langley Supersonic Transport Simulation Program)." (NASA CR-66126)

B. Boeing Document D6-10743. "Simulation of Three Supersonic Transport Configurations with the Boeing 367-80 In-Flight Dynamic Simulation Airplane." (NASA CR-66125)

C. Boeing Document D6-15000. "Large Transport Landing Characteristics as Simulated in Flight and on the Ground." (NASA CR-62036) B

D. Boeing Document D2-36343-1. "The BLITZ User's Manual."

E. Boeing Document D6-19857. "Variable Stability Interface Installation in 367-80 Airplane."

APPENDIX A - DESCRIPTION AND CALCULATION

SHEETS FOR AMES LARGE TRANSPORT

LINEARIZED -80 EQUATIONS OF MOTION

$$I_{xx}\dot{P} = q_0 Sb\left(C_{l_\beta} \times \beta + C_{l_P} \times P + C_{l_R} \times R + C_{l_{\delta_w}} \times \delta_w + C_{l_{\delta_r}} \times \delta_r\right)$$

$$I_{YY}\dot{Q} = q_0 S\bar{c}\left(C_{m_\alpha} \times \Delta\alpha + C_{m_{\dot\alpha}} \times \dot\alpha + C_{m_Q} \times Q + C_{m_{\delta_e}} \times \delta_e + C_{m_{\delta_{ab}}} \times \delta_{ab} + C_{m_{\Delta T}} \times \Delta T\right)$$

$$I_{ZZ}\dot{R} = q_0 Sb\left(C_{n_\beta} \times \beta + C_{n_P} \times P + C_{n_R} \times R + C_{n_{\delta_w}} \times \delta_w + C_{n_{\delta_r}} \times \delta_r\right)$$

$$\Delta\dot{V} = -\frac{\rho S V_0}{m} C_{D_{TRIM}} \Delta V - \frac{\rho S V_0^2}{2m}\left(C_{D_\alpha} \times \Delta\alpha + C_{D_{\delta_{ab}}} \times \delta_{ab}\right) + \frac{1}{m}\Delta T - g\gamma$$

$$\dot\gamma = \frac{\rho S V_0}{2m}\left(C_{L_\alpha} \times \Delta\alpha + C_{L_{\delta_{ab}}} \times \delta_{ab} + C_{L_{\delta_e}} \times \delta_e\right) + \frac{T_0 \Delta\alpha}{m V_0} + \left(\frac{2g}{V_0^2} - \frac{T_0 \alpha_0}{m V_0^2}\right)\Delta V + \frac{\alpha_0}{m V_0}\Delta T$$

$$R_w = \frac{\rho S V_0}{2m}\left(C_{Y_\beta} \times \beta + C_{Y_P} \times P + C_{Y_R} \times R \quad C_{Y_{\delta_w}} \times \delta_w + C_{Y_{\delta_r}} \times \delta_r\right) + \frac{g}{V_0}\phi$$

$$\dot\alpha = Q - Q_w \quad ; \quad \Delta\alpha = \int \dot\alpha\, dt \quad ; \quad \gamma = \int \dot\gamma\, dt$$

$$\dot\beta = R_w - R \quad ; \quad \beta = \int \dot\beta\, dt \quad ; \quad \phi = \int P\, dt$$

In these equations the following variables are:

in radians : $\Delta\alpha$, β, δ_w, δ_r, δ_e, δ_{ab}, γ, Φ

in radians/sec: $\dot\alpha$, $\dot\beta$, P, Q, R, $\dot\gamma$, R_w

in feet/sec : ΔV

in lbs : ΔT

These equations are derived from WADC, Technical Note 55-747 by R.M. Howe, June 1956.

They are valid for small perturbations around the trimmed level flight condition.

Eliminating R_w and changing the units of the variables to the following: in degrees : $\Delta\alpha$, β, δ_w, δ_r, δ_e, δ_{ab}, γ, ϕ.

in degrees/sec : $\dot{\alpha}$, $\dot{\beta}$, P, Q, R, $\dot{\gamma}$.

(α_0 in degrees) in feet/sec : ΔV

in pounds : ΔT

$$\dot{P} = \frac{q_0 Sb}{I_{XX}}\left(C_{l_\beta} \times \beta + C_{l_p} \times P + C_{l_R} \times R + C_{l_{\delta w}} \times \delta_w + C_{l_{\delta r}} \times \delta_r\right)$$

$$\dot{Q} = \frac{q_0 S\bar{c}}{I_{YY}}\left(C_{m_\alpha} \times \Delta\alpha + C_{m_{\dot{\alpha}}} \times \dot{\alpha} + C_{m_Q} \times Q + C_{m_{\delta e}} \times \delta_e + C_{m_{\delta ab}} \times \delta_{ab} + 57.3\, C_{m_{\Delta T}} \times \Delta T\right)$$

$$\dot{R} = \frac{q_0 Sb}{I_{ZZ}}\left(C_{n_\beta} \times \beta + C_{n_p} \times P + C_{n_R} \times R + C_{n_{\delta w}} \times \delta_w + C_{n_{\delta r}} \times \delta_r\right)$$

$$\Delta\dot{V} = -\frac{\rho S V_0}{m} C_{D_{TRIM}}\, \Delta V - \frac{\rho S V_0^2}{2m \times 57.3}\left(C_{D_\alpha} \times \Delta\alpha + C_{D_{\delta ab}} \times \delta_{ab}\right) + \frac{1}{m}\Delta T - \frac{g}{57.3}\gamma$$

$$\dot{\gamma} = \frac{\rho S V_0}{2m}\left(C_{L_\alpha} \times \Delta\alpha + C_{L_{\delta ab}} \times \delta_{ab} + C_{L_{\delta e}} \times \delta_e + \frac{T_0 \Delta\alpha}{m V_0}\right) + 57.3\left(\frac{2g}{V_0^2}\right)\Delta V - \frac{T_0 \alpha_0}{m V_0^2}\Delta V + \frac{\alpha_0}{m V_0}\Delta T$$

$$\dot{\beta} = \frac{\rho S V_0}{2m}\left(C_{Y_\beta} \times \beta + C_{Y_p} \times P + C_{Y_R} \times R + C_{Y_{\delta w}} \times \delta_w + C_{Y_{\delta r}} \times \delta_r\right) + \frac{g}{V_0}\phi - R$$

$$\dot{\alpha} = Q - \dot{\gamma}$$

$$\Delta\alpha = \int \dot{\alpha}\, dt \;;\quad \beta = \int \dot{\beta}\, dt \;;\quad \gamma = \int \dot{\gamma}\, dt \;;\quad \phi = \int P\, dt$$

In these equations the aerodynamic and control coefficients have the following units: /LB : $C_{m_{\Delta T}}$

/Radian : C_{l_β}, $C_{l_{\delta w}}$, $C_{l_{\delta r}}$, C_{m_α}, $C_{m_{\delta e}}$, $C_{m_{\delta ab}}$, C_{n_β}, $C_{n_{\delta w}}$, $C_{n_{\delta r}}$, C_{D_α}, $C_{D_{\delta ab}}$, C_{L_α}, $C_{L_{\delta ab}}$, C_{Y_β}, $C_{Y_{\delta w}}$, $C_{Y_{\delta r}}$

sec/radian : C_{l_p}, C_{l_R}, $C_{m_{\dot{\alpha}}}$, C_{m_Q}, C_{n_p}, C_{n_R}, C_{Y_p}, C_{Y_R}

THE FOLLOWING SCALE FACTORS WILL BE USED:

-5β, Q, $-5\dot{\gamma}$, $5\dot{\alpha}$, $5\Delta\alpha$, 5γ, ΔV, $-5P$, $-10\dot{\beta}$, $+5\dot{\beta}$, -2ϕ, $\pm 10R$, $5.25\delta_{e_c}$, $\pm 10\delta_{ab}$, $\pm 10\delta_{r_c}$, $+\delta_{\omega_c}$, $\pm 3\delta_{th_c}$,

where $3\delta_{th_c}$ in degrees $= \frac{\Delta T}{278}$

$$-5P = -\int\Big[\frac{q_0 Sb}{I_{xx}}(-C_{l_\beta})(-5\beta) + \frac{q_0 Sb}{I_{xx}}\left(\frac{C_{l_{\delta r}}}{2}\right)(10\delta_{r_c}) + \frac{q_0 Sb}{I_{xx}}(5.0C_{l_{\delta\omega}})(\delta_{\omega_c})$$
$$+ \frac{q_0 Sb}{I_{xx}}\left(\frac{C_{l_R}}{2}\right)(10R) + \frac{q_0 Sb}{I_{xx}}(-C_{l_p})(-5P)\Big]\,dt$$

$$-10R = -\int\Big[\frac{q_0 Sb}{I_{zz}}(-2C_{n_p})(-5P) + \frac{q_0 Sb}{I_{zz}}(10C_{n_{\delta\omega}})(\delta_{\omega_c}) + \frac{q_0 Sb}{I_{zz}}(-C_{n_{\delta r}})(-10\delta_{r_c})$$
$$+ \frac{q_0 Sb}{I_{zz}}(2C_{n_\beta})(5\beta) + \frac{q_0 Sb}{I_{zz}}(-C_{n_{\dot\beta}})(-10\dot{\beta}) + \frac{q_0 Sb}{I_{zz}}(-C_{n_R})(-10R)\Big]\,dt$$

$$5\dot{\beta} = -\Big[\frac{\rho S V_0}{2m}(-C_{Y_\beta})(5\beta) + \frac{\rho S V_0}{2m}(C_{Y_p})(-5P) + \left(.5 - \frac{\rho S V_0}{2m}\frac{C_{Y_R}}{2}\right)(10R)$$
$$+ \frac{\rho S V_0}{2m}(-5.0C_{Y_{\delta\omega}})(\delta_{\omega_c}) + \frac{\rho S V_0}{2m}\left(\frac{C_{Y_{\delta r}}}{2}\right)(-10\delta_{r_c}) - \frac{2.5g}{V_0}(-2\phi)\Big]$$

$$-2\phi = -4\int(.5P)\,dt$$

$$-5\beta = -\int(5\dot{\beta})\,dt$$

$$-5\dot{\gamma} = +\frac{\rho S V_0}{2m}\left(\frac{C_{L_{\delta e}}}{1.05}\right)\left(5.25\,\delta_{e_c}\right) + \frac{1390\,\alpha_0}{mV_0}\left(3\delta_{th_c}\right) + \frac{\rho S V_0}{2m}\left(.5C_{L_{\delta ab}}\right)\left(-10\delta_{ab_c}\right)$$

$$+\left(\frac{\rho S V_0}{2m}C_{L_\alpha} + \frac{T_0}{mV_0}\right)\left(5\Delta\alpha\right) - \left[286\left(\frac{2g}{V_0^2}\right) - \frac{5T_0\alpha_0}{mV_0^2}\right]\left(\Delta V\right)$$

$$\Delta V = -\int\left[\frac{278}{m}\left(-3\delta_{th_c}\right) + \frac{\rho S V_0}{m}C_{D_{TRIM}}\left(\Delta V\right) + \frac{\rho S V_0^2}{2m \times 57.3}\left(\frac{C_{D_\alpha}}{5}\right)\left(5\Delta\alpha\right)\right.$$

$$\left. + \frac{\rho S V_0^2}{2m \times 57.3}\left(-\frac{C_{D_{\delta ab}}}{10}\right)\left(-10\delta_{ab_c}\right) + \frac{2g}{57.3}\left(5\gamma\right)\right]dt$$

$$Q = -\int\left[\frac{q_0 S\bar{c}}{I_{YY}}\left(-57.3C_{m_{\Delta V}}\right)\left(\Delta V\right) + \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(-.2C_{m_\alpha}\right)\left(5\Delta\alpha\right)\right.$$

$$+ \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(278 \times 57.3\ C_{m_{\Delta T}}\right)\left(-3\delta_{th_c}\right) + \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(-.1C_{m_{\delta ab}}\right)\left(10\delta_{ab_c}\right)$$

$$+ \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(-\frac{C_{m_{\delta e}}}{5.25}\right)\left(5.25\,\delta_{e_c}\right) + \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(-.2C_{m_{\dot\alpha}}\right)\left(5\dot{\alpha}\right)$$

$$\left. + \frac{q_0 S\bar{c}}{\delta I_{YY}}\left(-C_{m_Q}\right)\left(Q\right)\right] dt$$

$$-5\dot{\alpha} = -\left[5\left(Q\right) + \left(-5\dot{\gamma}\right)\right]$$

$$5\Delta\alpha = -\int\left(-5\dot{\alpha}\right)dt$$

$$5\gamma = -\int\left(-5\dot{\gamma}\right)dt$$

The above equations are written in the body axes. In order to convert to stability axes and also to include the effect of the cross-product of inertia, I_{xz}, the following changes were made in both the -80 and the A.L.T. calculations:

a.) The moments of inertia $I_{xx}, I_{yy}, I_{zz}, I_{xz}$ were converted from body axes to stability axes $I'_{xx}, I'_{yy}, I'_{zz}, I'_{xz}$, using the equations:

$$I'_{xx} = I_{xx}\cos^2\alpha + I_{zz}\sin^2\alpha - 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{yy} = I_{yy}$$

$$I'_{zz} = I_{zz}\cos^2\alpha + I_{xx}\sin^2\alpha + 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{xz} = (I_{xx} - I_{zz})\sin\alpha\cos\alpha + I_{xz}(\cos^2\alpha - \sin^2\alpha)$$

b.) The effect of the cross-product of inertia was included by:

i) Replacing I'_{xx} by $I'_{xx} - \dfrac{I'^{2}_{xz}}{I'_{zz}}$

and I'_{zz} by $I'_{zz} - \dfrac{I'^{2}_{xz}}{I'_{xx}}$

ii) Replacing C_{l_β} by $C_{l_\beta} + \dfrac{I'_{xz}}{I'_{zz}} C_{n_\beta}$

C_{l_p} by $C_{l_p} + \dfrac{I'_{xz}}{I'_{zz}} C_{n_p}$

etc...

and C_{n_β} by $C_{n_\beta} + \dfrac{I'_{xz}}{I'_{xx}} C_{l_\beta}$

C_{n_p} by $C_{n_p} + \dfrac{I'_{xz}}{I'_{xx}} C_{l_p}$

etc...

$q_0 = .5\rho V_0^2$

$q_0 = 46.4$

$q_0 S = 46.4 \times 2821 = 130{,}894$

$q_0 S b = (130{,}894) \times 130.8 = 17.12 \times 10^6$

$q_0 S \bar{c} = 130{,}894 \times 20.1 = 2.631 \times 10^6$

$$\frac{q_0 S b}{I_{XX}} = \frac{17.12 \times 10^6}{2.57 \times 10^6} = 6.66$$

$$\frac{q_0 S \bar{c}}{I_{YY}} = \frac{2.631 \times 10^6}{2.25 \times 10^6} = 1.169$$

$$\frac{q_0 S b}{I_{ZZ}} = \frac{17.12 \times 10^6}{4.73 \times 10^6} = 3.619$$

$\alpha_0 = \alpha_{WING,TRIM}$
α_0 IN DEGREES

$V_0 = 197.5$ FT/SEC

$V_0^2 = 39.01 \times 10^3$

$mV_0 = 4660 \times 197.5 = 920.35 \times 10^3$

$$\frac{\alpha_0}{mV_0} = \frac{8.5}{920.35 \times 10^3} = .9236 \times 10^{-5}$$

$$\frac{T_0 \alpha_0}{mV_0^2} = \frac{18194 \times 8.5}{4660 \times 39.01 \times 10^3} = .8507 \times 10^{-3}$$

$$\frac{T_0}{mV_0} = \frac{18{,}194}{920.35 \times 10^3} = 19.769 \times 10^{-3}$$

$\rho = .002377$

$\rho S = .002377 \times 2821 = 6.7055$

$$\frac{\rho S}{m} = \frac{6.7055}{4660} = .001439$$

$$\frac{\rho S V_0}{2m} = \frac{6.7055 \times 197.5}{2 \times 4660} = .1421$$

$$\frac{\rho S V_0^2}{2m} = \frac{6.7055 \times 39.01 \times 10^3}{9320} = 28.06$$

$$\frac{g}{V_0} = \frac{32.2}{197.5} = .1630$$

$$\frac{2g}{V_0^2} = \frac{64.4}{39.01 \times 10^3} = .00165$$

367-80 ANALOG

	POTENTIOMETER NO.	POTENTIOMETER SETTING	VARIABLE	CALCULATED FROM
LIFT AMPL 33	42	.0704	$+5.25\delta_{e_c}$	$+\frac{1}{1.05} C_{L_{\delta e}} \frac{\rho S V_0}{2m}$
	43	.0128	$+3\delta_{thc}$	$+1390\left(\frac{\alpha_0}{mV_0}\right)$
	44	.0575	$-10\delta_{abc}$	$-.5 C_{L_{\delta ab}} \frac{\rho S V_0}{2m}$
	45	.7900	$+5\Delta\alpha$	$+C_{L\alpha}\frac{\rho S V_0}{2m} + \left(\frac{T_0}{mV_0}\right)$
	46	.4679	$+\Delta V$	$+286\left(\frac{2g}{V_0^2}\right) - \left(\frac{57 T_0 \alpha_0}{mV_0^2}\right)$
				$\alpha_0 = \alpha_{TRIM,WING}$ IN DEG
DRAG AMPL 31	47	.0597	$-3\delta_{thc}$	$+\frac{278}{m}$
	48	.0395	$+\Delta V$	$+C_{D_{TRIM}}\left(\frac{\rho S V_0}{m}\right)$
	49	.0533	$+5\Delta\alpha$	$+C_{D\alpha}\left(\frac{.1\rho S V_0^2}{57.3m}\right)$
	50	0	$-10\delta_{abc}$	$-C_{D_{\delta ab}}\left(\frac{.1\rho S V_0^2}{2\times 57.3m}\right)$
	51	.1124	$+5\gamma$	$+\frac{2g}{573}$
PITCH AMPL 35	40	.0500	$+\Delta V$	$-57.3 C_{m_{\Delta V}}\left(\frac{q_0 S \bar{c}}{I_{YY}}\right)$
	53	.2595	$+5\Delta\alpha$	$-.2 C_{m\alpha}$ (")
	54	0	$-3\delta_{thc}$	$+57.3\times 278 C_{m_{\Delta T}}$ (")
	55	.0150	$+10\delta_{abc}$	$-.1 C_{m_{\delta ab}}$ (")
	56	.2272	$+5.25\delta_{e_c}$	$-.2 C_{m_{\delta e}}$ (")
	57	.0634	$+5\dot{\alpha}$	$-.2 C_{m_{\dot{\alpha}}}$ (")
	58	.8273	$+Q$	$-C_{m_Q}$ (")
AMPL 18	59	.5000	$+Q$	SCALE FACTOR

367-80 ANALOG

	POTENTIOMETER NO.	POTENTIOMETER SETTING	VARIABLE	CALCULATED FROM
ROLL AMPL. 17	22	$.1177^{10}$	-5β	$-\left(C_{l_\beta} + \frac{I'_{xz}}{I'_{zz}} C_{n_\beta}\right)\left(\frac{q_0 S b}{I'_{xx} - \frac{I'^2_{xz}}{I'_{zz}}}\right)$
	23	.0544	$+10\delta_{r_c}$	$+.5\left(C_{l_{\delta r}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta r}}\right)($ " $)$
	24	$.2005^{10}$	$+\delta_{\omega_c}$	$+5\left(C_{l_{\delta \omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)($ " $)$
	25	.3545	$+10R$	$+.5\left(C_{l_R} + \frac{I'_{xz}}{I'_{zz}} C_{n_R}\right)($ " $)$
	26	.8000	$-5P$	$-\left(C_{l_p} + \frac{I'_{xz}}{I'_{zz}} C_{n_p}\right)($ " $)$
YAW AMPL. 21	27	.1000	$-5P$	$-2\left(C_{n_p} + \frac{I'_{xz}}{I'_{xx}} C_{l_p}\right)\left(\frac{q_0 S b}{I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}}\right)$
	28	.0347	$+\delta_{\omega_c}$	$+10\left(C_{n_{\delta\omega}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta\omega}}\right)($ " $)$
	29	.2725	$-10\delta_{r_c}$	$-\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta r}}\right)($ " $)$
	30	$.0700^{10}$	$+5\beta$	$+2\left(C_{n_\beta} + \frac{I'_{xz}}{I'_{xx}} C_{l_\beta}\right)($ " $)$
	31	.2700	$-10\dot\beta$	$-\left(C_{n_{\dot\beta}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\dot\beta}}\right)($ " $)$
	32	.4000	$-10R$	$-\left(C_{n_R} + \frac{I'_{xz}}{I'_{xx}} C_{l_R}\right)($ " $)$
SIDE FORCE AMPL. 23	33	.1191	$+5\beta$	$-C_{Y_\beta}\frac{\rho S V_0}{2m}$
	34	.0384	$-5P$	$+C_{Y_p}\frac{\rho S V_0}{2m}$
	35	.5052	$+10R$	$+.5\,C_{Y_R}\frac{\rho S V_0}{2m} + .5$
	36	.0179	$+\delta_{\omega_c}$	$-5\,C_{Y_{\delta\omega}}\frac{\rho S V_0}{2m}$
	37	.0150	$-10\delta_{r_c}$	$+.5\,C_{Y_{\delta r}}\frac{\rho S V_0}{2m}$
	38	.4076	-2ϕ	$+2.5\,\frac{g}{V_0} =$
AMPL. 34	39	$.4000^{10}$	$+.5P$	SCALE FACTOR

SIMULATING: AMES LARGE TRANSPORT

367-80

WEIGHT: 150 000 LBS.
C.G. LOCATION: .30 $\bar{c}$
ALTITUDE: SEA LEVEL

MOMENTS OF INERTIA IN BODY AXES

$I_{xx} = 2.57 \times 10^6$ SLUG FT^2
$I_{yy} = 2.25 \times 10^6$ SLUG FT^2
$I_{zz} = 4.73 \times 10^6$ SLUG FT^2
$I_{xz} = .16 \times 10^6$ SLUG FT^2

FLIGHT CONDITION

FLAP SETTING = 30°
BLOWING PRESSURE RATIO = 1.0
SPEED BRAKE SETTING = 6°
GEAR: DOWN

GEOMETRY

$S = 2821$ FT^2
$\bar{c} = 20.1$ FT
$b = 130.8$ FT

TRIM

SPEED = 117 KTS (197.5 FT/SEC)
$\alpha_{TRIM,BODY} = 6.5°$
$\alpha_{TRIM,WING} = 8.5°$

DEPENDENT VARIABLES

$q_{TRIM} = 46.4$
$q_{TRIM}S = 130{,}894$
$THRUST_{TRIM} = 18{,}194$ LBS
MASS = 4660 SLUGS
$C_{L_{TRIM}} = 1.146$

MODE SHAPES

SHORT PERIOD	$\omega_U = 1.42$ $\omega_D = 1.04$ $\zeta = .68$	RAD/SEC RAD/SEC
PHUGOID	$\omega_U = .157$ $\omega_D = .157$ $\zeta = .0906$	RAD/SEC RAD/SEC
DUTCH ROLL	$\omega_U = .77$ $\omega_D = .77$ $\zeta = .018$ $\frac{\lvert\phi\rvert}{\lvert\beta\rvert} = 1.584$	RAD/SEC RAD/SEC
ROLL T.C.	= 1.04	SEC
SPIRAL DIVERG.	T.C. = 15.7 D.A. = −10.87	SEC SEC

CALC.		REVISED	DATE	VARIABLE STABILITY AIRPLANE DESCRIPTION
CHECK				
APPD.				
APPD.				THE BOEING COMPANY RENTON, WASH.

TD 1656-R3

$_{BO\delta_{ab}} \times \delta_{ab} + \Delta T_{-BO\Delta\alpha} \times \Delta\alpha$

$_{L.T.} + \delta_{ab_{\Delta T-BO}} \times \Delta T_{-BO} + \delta_{ab_{\delta E}} \times \delta_E + \delta_{ab_Q} \times Q$

$\alpha + \delta_{e_{\dot\alpha}} \times \dot\alpha + \delta_{e_Q} \times Q$

δ_E

$_{W} \times \delta_W + \delta_{w_{\delta R}} \times \delta_R + \delta_{w_{\delta r}} \times \delta r$

$+ \delta_{r_{\delta W}} \times \delta_W + \delta_{r_{\delta R}} \times \delta_R + \delta_{r_{\delta w_c}} \times \delta_{w_c}$

δe ; δr ; $\delta \omega$; δ_{ab} ; $\Delta\alpha$; β
δ_E ; δ_R ; δ_W ;
P ; Q ; R ; $\dot\beta$; $\dot\alpha$
ΔT_{-BO} ; $\Delta T_{A.L.T.}$
ΔV

A.L.T. MATRIX EQUATIONS

AMES LARGE TRANSPORT

$$I'_{xx} = I_{xx}\cos^2\alpha + I_{zz}\sin^2\alpha - 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{xx} = 17.5\times10^6\ .99778 + (45\times10^6)(.00222) - 2(.95\times10^6)(.04706) = \underline{\underline{+17.4715\times10^6}}$$

$$I'_{zz} = I_{zz}\cos^2\alpha + I_{xx}\sin^2\alpha + 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{zz} = (45\times10^6)(.99778) + (17.5\times10^6)(.00222) + 2(.95\times10^6)(.04706) = \underline{\underline{45.0283\times10^6}}$$

$$I'_{xz} = (I_{xx} - I_{zz})\sin\alpha\cos\alpha + I_{xz}(\cos^2\alpha - \sin^2\alpha)$$

$$I'_{xz} = (17.5\times10^6 - 45\times10^6)(.04706) + (.95\times10^6)(.99778 - .00222) = \underline{\underline{-.3484\times10^6}}$$

$$\frac{I'_{xz}}{I'_{zz}} = \frac{-.3484\times10^6}{45.0283\times10^6} = -.00773$$

$$\frac{I'_{xz}}{I'_{xx}} = \frac{-.3484\times10^6}{+17.4715\times10^6} = -.01994$$

$\alpha_0 = \alpha_{TRIM,BODY} = 2.7°$

$$\frac{q_0 S\bar{c}}{I_{YY}} = \frac{46.4\times5500\times28.75}{30\times10^6} = \underline{\underline{.2446}}$$

$$\frac{q_0 Sb}{I'_{xx} - \frac{I'^2_{xz}}{I'_{zz}}} = \frac{46.4\times5500\times215}{17.4715\times10^6 - \left[\frac{(-.3484\times10^6)^2}{45.0283\times10^6}\right]} = 3.1405$$

$$\frac{q_0 Sb}{I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}} = \frac{54.868\times10^6}{45.0283\times10^6 - \left[\frac{.12138\times10^{12}}{17.4715\times10^6}\right]} = 1.2186$$

$$\frac{q_0 S}{m} = \frac{46.4\times5500}{15{,}528} = 16.435$$

367-80 AIRPLANE

$\alpha_0 = \alpha_{TRIM,BODY} = 6.5°$

$$I'_{xx} = I_{xx}\cos^2\alpha + I_{zz}\sin^2\alpha - 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{xx} = (2.57\times10^6)(.98718) + (4.73\times10^6)(.0128) - 2(.16\times10^6)(.1132)(.99357) = \underline{\underline{2.5617\times10^6}}$$

$$I'_{zz} = I_{zz}\cos^2\alpha + I_{xx}\sin^2\alpha + 2I_{xz}\sin\alpha\cos\alpha$$

$$I'_{zz} = (4.73\times10^6)(.98718) + (2.57\times10^6)(.0128) + (.03599\times10^6) = \underline{\underline{4.7383\times10^6}}$$

$$I'_{xz} = (I_{xx} - I_{zz})\sin\alpha\cos\alpha + I_{xz}(\cos^2\alpha - \sin^2\alpha)$$

$$I'_{xz} = [(2.57\times10^6) - (4.73\times10^6)].11247 + (.16\times10^6)(.98718 - .0128) = \underline{-.08704\times10^{-6}}$$

$$\frac{I'_{xz}}{I'_{zz}} = \frac{-.08704\times10^6}{+4.7383\times10^6} = -.01836 \qquad \frac{I'_{xz}}{I'_{xx}} = \frac{-.08704\times10^6}{+2.5617\times10^6} = -.034$$

$$\frac{q_0 S\bar{c}}{I_{YY}} = \frac{46.4\times2821\times20.1}{2.25\times10^6} = 1.169$$

$$\frac{q_0 Sb}{I'_{xx} - \frac{I'^2_{xz}}{I'_{zz}}} = \frac{46.4\times2821\times130.8}{2.5617\times10^6 - \left[\frac{(-.08704\times10^6)^2}{4.7383\times10^6}\right]} = 6.688$$

$$\frac{q_0 Sb}{I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}} = \frac{46.4\times2821\times130.8}{4.7383\times10^6 - \left[\frac{7.576\times10^9}{2.5617\times10^6}\right]} = 3.615$$

$$\frac{q_0 S}{m} = \frac{46.4\times2821}{4660} = 28.089$$

PITCH

$$K_{PITCH} = \frac{\left.\frac{q_0 S\bar{c}}{I_{YY}}\right]_{A.L.T.}}{\left.\frac{q_0 S\bar{c}}{I_{YY}}\right]_{-80}} = \frac{.2446}{1.169} = .2092$$

ROLL

$$K_{ROLL} = \frac{\left.\frac{q_0 Sb}{I' - \frac{I'^2_{xz}}{I'_{zz}}}\right]_{A.L.T.}}{\left.\frac{q_0 Sb}{I'_{xx} - \frac{I'^2_{xz}}{I'_{zz}}}\right]_{-80}} = \frac{3.1405}{6.688} = .4696$$

LIFT, DRAG

$$K_{LIFT\ DRAG} = \frac{\left.\frac{q_0 S}{m}\right]_{A.L.T.}}{\left.\frac{q_0 S}{m}\right]_{-80}} = \frac{16.435}{28.089} = .585$$

YAW

$$K_{YAW} = \frac{\left.\frac{q_0 Sb}{I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}}\right]_{A.L.T.}}{\left.\frac{q_0 Sb}{I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}}\right]_{-80}} = \frac{1.2186}{3.615} = .337$$

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PITCH EQUATIONS

MATRIX GAIN CALCULATIONS

EXAMPLE:

$$\delta_{e_{\Delta\alpha}} = \frac{K\left(C_{m_\alpha}\right)_{A.L.T.} - C_{m_{\alpha-80}}}{C_{m_{\delta e-80}}}$$

$$= \frac{.2092\,(-2.07) - (-1.10)}{-.975} = \frac{-.4330 + 1.10}{-.975} = \frac{+.667}{-.975} = \underline{\underline{-.6841}}$$

$$\delta_{e_{\dot\alpha}} = \frac{K\left(C_{m_{\dot\alpha}}\right)_{A.L.T.} - C_{m_{\dot\alpha-80}}}{C_{m_{\delta e-80}}} = -.1599$$

$$\delta_{e_Q} = \frac{K\left(C_{m_Q}\right)_{A.L.T.} - C_{m_{Q-80}}}{C_{m_{\delta e-80}}} = -.216$$

$$\delta_{e_{\Delta V}} = \frac{K\left(57.3 \times C_{m_{\Delta V}}\right)_{A.L.T.} - C_{m_{\Delta V-80}}}{C_{m_{\delta e-80}}} = -.0438$$

$$\delta_{e_{\delta E}} = \frac{K\left(C_{m_{\delta E}}\right)_{A.L.T.}}{C_{m_{\delta e-80}}} = +.3346$$

CONT'D.

PITCH EQUATIONS (CONT'D)

$\delta_{e_{\Delta T-80}} =$ FUNCTION (See Page A28)

$\delta_{e_{\delta ab_c}} =$ FUNCTION (See Page A29)

$$\delta_{e_c} = \overbrace{-.6841\ \Delta\alpha}^{\delta_{e_{\Delta\alpha}}} \overbrace{-\ .1599\ \dot{\alpha}}^{+\ \delta_{e_{\dot{\alpha}}}} \overbrace{-\ .216\ Q}^{+\ \delta_{e_Q}} \overbrace{-\ .0438\ \Delta V}^{+\ \delta_{e_{\Delta V}}}$$

$$\overbrace{+\ .3346\ \delta_E}^{+\ \delta_{e_{\delta E}}} \overbrace{+\ \text{function}\ \Delta T_{-80}}^{+\ \delta_{e_{\Delta T-80}}} \overbrace{+\ \text{function}\ \delta_{ab_c}}^{+\ \delta_{e_{\delta ab_c}}}$$

DRAG AXIS EQUATIONS

$$\frac{m_{-80}}{m_{A.L.T.}} = \frac{4660}{15,528} = .300$$

$$\left(2\frac{q_o S}{V_o} C_{D_{TRIM}}\right)_{-80} - \left(2\frac{q_o S}{V_o} C_{D_{TRIM}} + q_o S C_{D_{\Delta V}}\right)_{A.L.T.} \frac{m_{-80}}{m_{A.L.T.}}$$

$$\Delta T_{-80_{\Delta V}} = \left(2\frac{46.4 \times 2821}{197.5} \times .139\right)_{-80} - \left(2\frac{46.4 \times 5500}{197.5} \times .450 + 0\right)_{A.L.T.} = \underline{\underline{-164.63}}$$

$$\Delta T_{-80_{\Delta T_{A.L.T.}}} = \frac{m_{-80}}{m_{A.L.T.}}\left(1 - q_o S C_{D_{\Delta T}}\right)_{A.L.T.} = +.300$$

$$\Delta T_{-80_{\delta_{ab}}} = q_o S \frac{C_{D_{ab}}}{57.3} = 0.0$$

$$\Delta T_{-80_{\Delta\alpha}} = \left(q_o S \frac{C_{D_\alpha}}{57.3}\right)_{-80} - \left[\left(q_o S \frac{C_{D_\alpha}}{57.3}\right)_{A.L.T.} \frac{m_{-80}}{m_{A.L.T.}}\right] = -186.96$$

$$\Delta T_{-80_{\Delta V}} \times \Delta V + \Delta T_{-80_{\Delta T_{A.L.T.}}} \times \Delta T_{A.L.T.} + \Delta T_{-80_{\delta_{ab}}} \times \delta_{ab_c} + \Delta T_{-80_{\Delta\alpha}} \times \Delta\alpha$$

$$\Delta T_{-80} = -164.63\ \Delta V + .300\ \Delta T_{A.L.T.} + 0\ \delta_{ab_c} - 186.96\ \Delta\alpha$$

LIFT AXIS EQUATIONS

$$\delta_{ab_{\Delta\alpha}} = \frac{\left(\frac{q_oS}{\bar{v}m} C_{L\alpha} + \frac{T_o}{m}\right)_{A.L.T.} - \left(\frac{q_oS}{\bar{v}m} C_{L\alpha} + \frac{T_o}{m}\right)_{-80}}{\left(\frac{q_oS}{\bar{v}m} C_{L\delta_{ab}}\right)_{-80}}$$

$$\delta_{ab_{\Delta\alpha}} = \frac{\left(16.435 \times 6.81 + \frac{114,787}{15,528}\right)_{A.L.T.} - \left(28.089 \times 5.418 + \frac{18,194}{4660}\right)_{-80}}{\left(28.089 \times -.808\right)_{-80}} = +1.62$$

$$\delta_{ab_{\dot\alpha}} = \frac{\left(\frac{q_oS}{\bar{v}m} C_{L\dot\alpha}\right)_{A.L.T.}}{\left(\frac{q_oS}{\bar{v}m} C_{Lab}\right)_{-80}} = +.2866$$

$$\delta_{ab_Q} = \frac{\left(\frac{q_oS}{\bar{v}m} C_{LQ}\right)_{A.L.T}}{\left(\frac{q_oS}{\bar{v}m} C_{Lab}\right)_{-80}} = -.5822$$

$$\delta_{ab_{\Delta T_{A.L.T.}}} = \frac{\left(\frac{\alpha_o}{m}\right)_{A.L.T.} + 57.3\left(\frac{q_oS}{\bar{v}m} C_{L\Delta T}\right)_{A.L.T.}}{\left(\frac{q_oS}{\bar{v}m} C_{Lab}\right)_{-80}} = -.7659 \times 10^{-5}$$

$$\delta_{ab_{\Delta T_{-80}}} = \frac{-\left(\frac{\alpha_o}{m}\right)_{-80}}{\left(\frac{q_oS}{\bar{v}m} C_{Lab}\right)_{-80}} = +8.037 \times 10^{-5}$$

$$\delta_{ab_{\delta_E}} = \frac{\left(\frac{q_oS}{\bar{v}m} C_{L\delta_E}\right)_{A.L.T.}}{\left(\frac{q_oS}{\bar{v}m} C_{Lab}\right)_{-80}} = -.2961$$

$$\delta_{ab_c} = \underbrace{1.62}_{\delta_{ab_{\Delta\alpha}}}\,\Delta\alpha + \underbrace{.2866}_{\delta_{ab_{\dot\alpha}}}\,\dot\alpha - \underbrace{.5822}_{\delta_{ab_Q}}\,Q$$

$$- \underbrace{.766 \times 10^{-5}}_{\delta_{ab_{\Delta T_{A.L.T.}}}}\,\Delta T_{A.L.T.} + \underbrace{8.037 \times 10^{-5}}_{\delta_{ab_{\Delta T_{-80}}}}\,\Delta T_{-80} - \underbrace{.2961}_{\delta_{ab_{\delta_E}}}\,\delta_E$$

ROLL EQUATIONS

MATRIX GAIN CALCULATIONS

$$\delta_{\omega_\beta} = \frac{K\left(C_{l_\beta} + \frac{I'_{xz}}{I'_{zz}} C_{n_\beta}\right)_{A.L.T.} - \left(C_{l_\beta} + \frac{I'_{xz}}{I'_{zz}} C_{n_\beta}\right)_{-80}}{\left(C_{l_{\delta\omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)_{-80}}$$

EXAMPLE:

$$= \frac{.4696\left[-.1955+(-.00773)(.218)\right] - \left[-.1743+(-.01836)(.0909)\right]}{+.06+(-.01836)(.003)}$$

$$= \frac{.4696(-.1955-.00169) - (-.1743-.00167)}{+.06}$$

$$= \frac{.4696(-.1972)+.1760}{+.06} = \frac{-.0926+.1760}{+.06} = \frac{+.0834}{+.06} = \underline{\underline{+1.391}}$$

$$\delta_{\omega_p} = \frac{K\left(C_{l_p} + \frac{I'_{xz}}{I'_{zz}} C_{n_p}\right)_{A.L.T.} - \left(C_{l_p} + \frac{I'_{xz}}{I'_{zz}} C_{n_p}\right)_{-80}}{\left(C_{l_{\delta\omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)_{-80}} = +.0776$$

$$\delta_{\omega_R} = \frac{K\left(C_{l_R} + \frac{I'_{xz}}{I'_{zz}} C_{n_R}\right)_{A.L.T.} - \left(C_{l_R} + \frac{I'_{xz}}{I'_{zz}} C_{n_R}\right)_{-80}}{\left(C_{l_{\delta\omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)_{-80}} = -.2186$$

$$\delta_{\omega_{\delta w}} = \frac{K\left(C_{l_{\delta w}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta w}}\right)_{A.L.T.} - \left(\text{NO CONTRIBUTION}\right)_{-80}}{\left(C_{l_{\delta\omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)_{-80}} = +.7623$$

$$\delta_{\omega_{\delta R}} = \frac{K\left(C_{l_{\delta R}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta R}}\right)_{A.L.T.} - \left(\text{NO CONTRIBUTION}\right)_{-80}}{\left(C_{l_{\delta\omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta\omega}}\right)_{-80}} = +.0252$$

CONT'D.

ROLL EQUATIONS
(CONT'D)

MATRIX GAIN CALCULATIONS

$$\delta_{\omega_{\delta r}} = \frac{K\left(\text{NO CONTRIBUTION}\right)_{A.L.T.} - \left(C_{\ell_{\delta r}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta r}}\right)_{-80}}{\left(C_{\ell_{\delta \omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta \omega}}\right)_{-80}} = -.2715$$

$$\delta_{\omega_{\dot\beta}} = \frac{K\left(C_{\ell_{\dot\beta}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\dot\beta}}\right)_{A.L.T.} - \left(C_{\ell_{\dot\beta}} - \frac{I'_{xz}}{I'_{zz}} C_{n_{\dot\beta}}\right)_{-80}}{\left(C_{\ell_{\delta \omega}} + \frac{I'_{xz}}{I'_{zz}} C_{n_{\delta \omega}}\right)_{-80}} = -.0305$$

YAW EQUATIONS

$$\delta_{r_\beta} = \frac{K\left(C_{n_\beta} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_\beta}\right)_{A.L.T.} - \left(C_{n_\beta} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_\beta}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_{\delta r}}\right)_{-80}} = +.2921$$

$$\delta_{r_p} = \frac{K\left(C_{n_p} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_p}\right)_{A.L.T.} - \left(C_{n_p} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_p}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_{\delta r}}\right)_{-80}} = -.6096$$

$$\delta_{r_R} = \frac{K\left(C_{n_R} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_R}\right)_{A.L.T.} - \left(C_{n_R} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_R}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_{\delta r}}\right)_{-80}} = -.1610$$

$$\delta_{r_{\delta \omega}} = \frac{K\left(C_{n_{\delta \omega}} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_{\delta \omega}}\right)_{A.L.T.} - \left(\text{NO CONTRIBUTION}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{\ell_{\delta r}}\right)_{-80}} = +.00911$$

CONT'D

YAW EQUATIONS (CONT'D)

MATRIX GAIN CALCULATIONS

$$\delta r_{\delta R} = \frac{K\left(C_{n_{\delta R}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta R}}\right)_{A.L.T.} - \left(\text{NO CONTRIBUTION}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta r}}\right)_{-80}} = +.5366$$

$$\delta r_{\delta w} = \frac{K\left(\text{NO CONTRIBUTION}\right)_{A.L.T.} - \left(C_{n_{\delta w}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta w}}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta r}}\right)_{-80}} = +.0128$$

$$\delta r_{\dot{\beta}} = \frac{K\left(C_{n_{\dot{\beta}}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\dot{\beta}}}\right)_{A.L.T.} - \left(C_{n_{\dot{\beta}}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\dot{\beta}}}\right)_{-80}}{\left(C_{n_{\delta r}} + \frac{I'_{xz}}{I'_{xx}} C_{l_{\delta r}}\right)_{-80}} = -1.1516$$

ΔT_{-80}	δ_{ab}	δ_e	VARIABLE		δ_ω	δ_r
−186.96	+1.62	−.6841	$\Delta\alpha$	β	+1.391	+.2921
—	+.2866	−.1599	$\dot{\alpha}$	$\dot{\beta}$	−.0305	−1.1516
—	−.5822	−.216	Q	P	+.0776	−.6096
−164.63	0	−.0438	ΔV	R	−.2186	−.1610
+.300	$-.766\times10^{-5}$	0	$\Delta T_{A.L.T.}$	δ_W	+.7623	+.00911
—	$+8.037\times10^{-5}$	—	ΔT_{-80}	δ_ω	—	+.0128
0	—	−.1323	δ_{ab}	δ_R	+.0252	+.5366
—	−.2961	+.3346	δ_E	δ_r	−.2715	—

Example: if 7 ; then the following equations apply

ΔT_{-80}	δ_{ab}	δ_e	
+217	+2.1	−.63	$\Delta\alpha$
−33	+.07	−.007	ΔV
+.25	-3×10^{-6}	$+4.6\times10^{5}$	ΔT_{SST}
—	$+1.7\times10^{-5}$	$+2\times10^{-4}$	ΔT_{-80}
0	−.09	+.38	δ_E

$$\Delta T_{-80} = 217\,\Delta\alpha - 33\,\Delta V + .25\,\Delta T_{A.L.T.}$$

$$\delta_{ab} = 2.1\,\Delta\alpha + .07\,\Delta V - 3\times10^{-6}\,\Delta T_{A.L.T.} + 1.7\times10^{-5}\,\Delta T_{-80} - .09\,\delta_E$$

$$\delta_e = -.63\,\Delta\alpha - .007\,\Delta V + 4.6\times10^{-5}\,\Delta T_{A.L.T.} + 2\times10^{-4}\,\Delta T_{-80} + .38\,\delta_E$$

LONG. CONFIG. #100 (BASIC) LAT. CONFIG. #1209 (BASIC)

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.000000E 02	LADIAX	1.209000E 03	PAGE	1.000000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.921000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710299E-02	COSAS	9.988900E-01	IXXPS	1.747152E 07	IZZPS	4.522838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865850E-01	DABQ	-5.822205E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540521E-02				
DCY8	4.648835E-03	DCY8D	-7.553659E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.662373E-03				

LONG. CONFIG. #100 (BASIC) LAT. CONFIG. #1209 (BASIC)

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.000000E 02	LADIAX	1.209000E 03	PAGE	2.000000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000F 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDAB	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000F 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.865572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003F-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						
P64A44	1.679143E-01								
P65A43	1.134826E 00								
P66A43	7.183666E-01								
P67A43	2.301697F-01								
P68A44	0.								
P69A43	6.946154E-02								
P70A44	1.756879F 00								
P72A46	1.869572F-01								
P73A46	1.500000E 00								
P74A46	8.231735E-01								
P76A46	-0.								
P79A47	5.731720E-01								
P80A48	0.								
P81A47	1.607372F-01								
P82A48	7.658660E-02								
P83A47	2.960689E 00								
P85A48	3.244436F 00								
P88A47	5.822206E 00								
P106A2	6.054950E-03								
P107A2	4.371610E-01								
P108A2	3.104758E-01								
P111A1	5.562472E-01								
P112A1	1.524660E 00								
P114A2	5.042006E-02								
P115A1	5.430222E-02								
P118A3	1.151619E 00								
P119A4	1.219217E 01								
P120A3	1.610243E 00								
P121A4	5.842168E-01								
P122A4	4.633850E 00								
P123A3	9.112884E-02								
P124A3	6.376025E-02								

AMES LARGE TRANSPORT ~ LONGITUDINAL

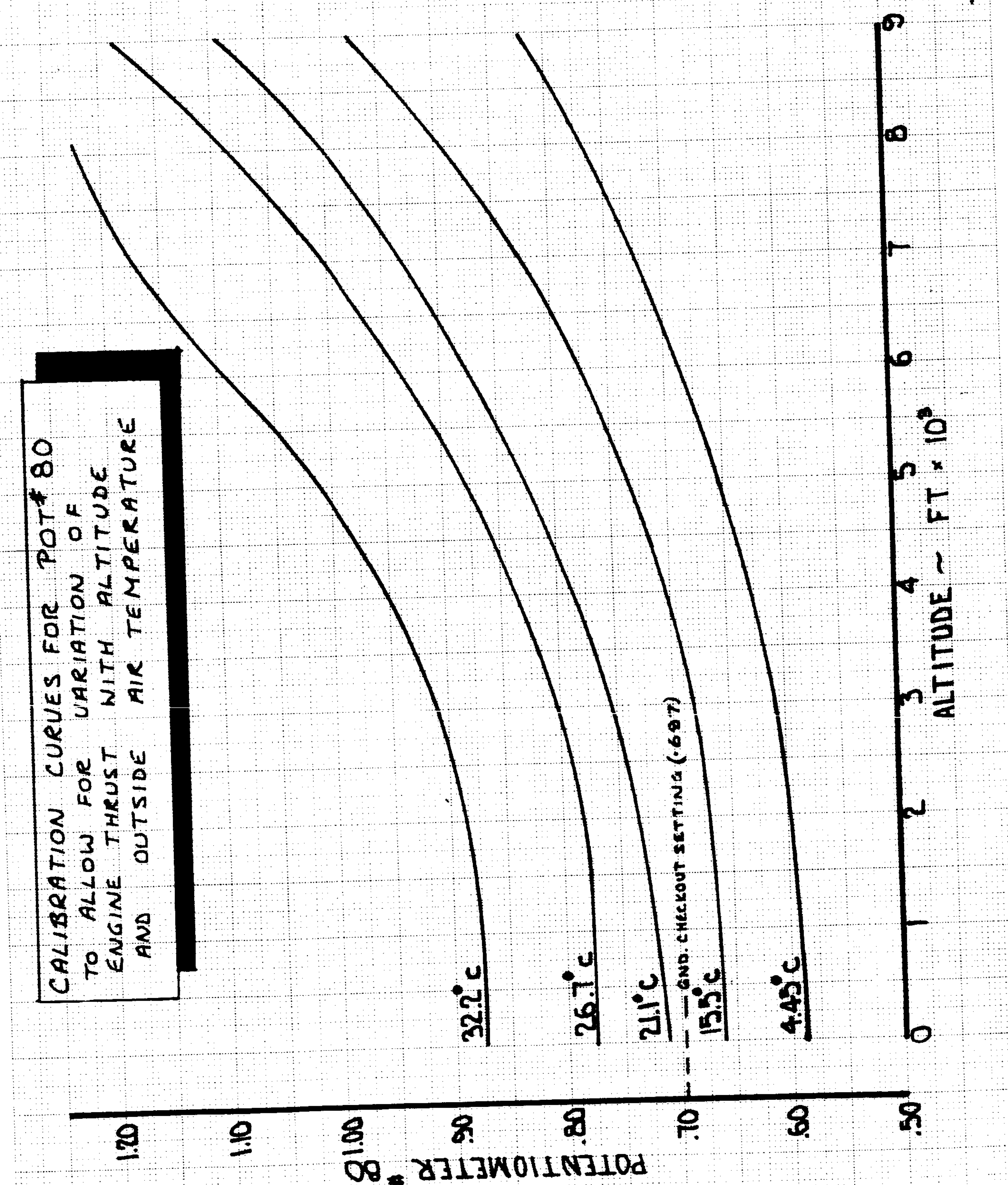
	POTENTIOMETER			VARIABLE	CALCULATED FROM
	NO.	SETTING	TO		
PITCH ($5.25\,\delta_{e_C}$)	62	.2620	A44	$+20\,\delta_{e_{TRIM}}$	SCALE FACTOR
	64	.1679	A44	$-5\dot{\alpha}$	$-\delta_{e_{\dot{\alpha}}}\,(1.05) = -(-.1599)\times 1.05 = .1679$
	65	$.1135^{\underline{10}}$	A43	$+Q$	$-\delta_{e_Q}\,(1.05\times 5) = -(-.216)\times 5.25 = 1.135$
	66	.7184	A43	$+5\Delta\alpha$	$-\delta_{e_{\Delta\alpha}}\,(1.05) = -(-.6841)\times 1.05 = .7183$
	67	.2284	A43	$+\Delta V$	$-\delta_{e_{\Delta V}}\,(1.05\times 5) = -\,-.0438\times 5.25 = .2302$
	68	.1800	A44	$.5\,\delta_{CLAM}$	function $\delta_{e_{\Delta T_{-80}}}$ compensation
	70	$.1757^{\underline{10}}$	A44	$+\delta_E$	$+\delta_{e_{\delta_E}}\,(1.05\times 5) = .3346\times 5.25 = 1.757$
	71	.1000	A49	$+10\,\delta_{ab_c}$	function $\delta_{e_{\delta_{ab_c}}}$ compensation
DRAG ($-.005\Delta T_{-80}$)	72	.1877	A46	$+5\Delta\alpha$	$-\Delta T_{\Delta\alpha}(.001) = -(-186.96)(.001) = .1870$
	73	$.150^{\underline{10}}$	↓	$-.001\Delta T_{A.L.T.}$	$+\Delta T_{\Delta T_{A.L.T.}}(5) = .300\times 5 = 1.50$
	74	.8238	↓	$+\Delta V$	$-\Delta T_{\Delta V}\,(.005) = -(-164.63)(.005) = .8232$
	76	0	↓	$+10\,\delta_{ab_c}$	$-\Delta T_{\delta_{ab}}(.0005) = 0.0$
	90	.697	A62	$-.005\Delta T_{-80}$	$+\dfrac{\delta_{th}}{\Delta T_{-80}}(600) = \dfrac{600}{861} = .697$ 861 based on $\dfrac{\Delta T}{\text{DEG CLAM}} = 1080$
LIFT ($10\,\delta_{ab_c}$)	79	.5732	A47	$-5\dot{\alpha}$	$+\delta_{ab_{\dot{\alpha}}}\,(2) = .2866\times 2 = .5732$
	81	.1656	A47	$-.005\Delta T_{-80}$	$+\delta_{ab_{\Delta T_{-80}}}(2000) = (8.04\times 10^{-5})(2\times 10^{3}) = .1607$
	82	.0766	A48	$-.001\Delta T_{A.L.T.}$	$-\delta_{ab_{\Delta T_{A.L.T.}}}(10000) = -(-.766\times 10^{-5})(10^{4}) = .0766$
	83	$.2961^{\underline{10}}$	A47	$+\delta_E$	$-\delta_{ab_{\delta_E}}\,(10) = -(-.2961)(10) = 2.961$
	85	$.3244^{\underline{10}}$	A48	$+5\Delta\alpha$	$+\delta_{ab_{\Delta\alpha}}\,(2) = 1.62\times 2 = 3.24$
	88	$.5822^{\underline{10}}$	A47	$+Q$	$-\delta_{ab_Q}\,(10) = -(-.5822)(10) = 5.822$

AMES LARGE TRANSPORT ~ LATERAL

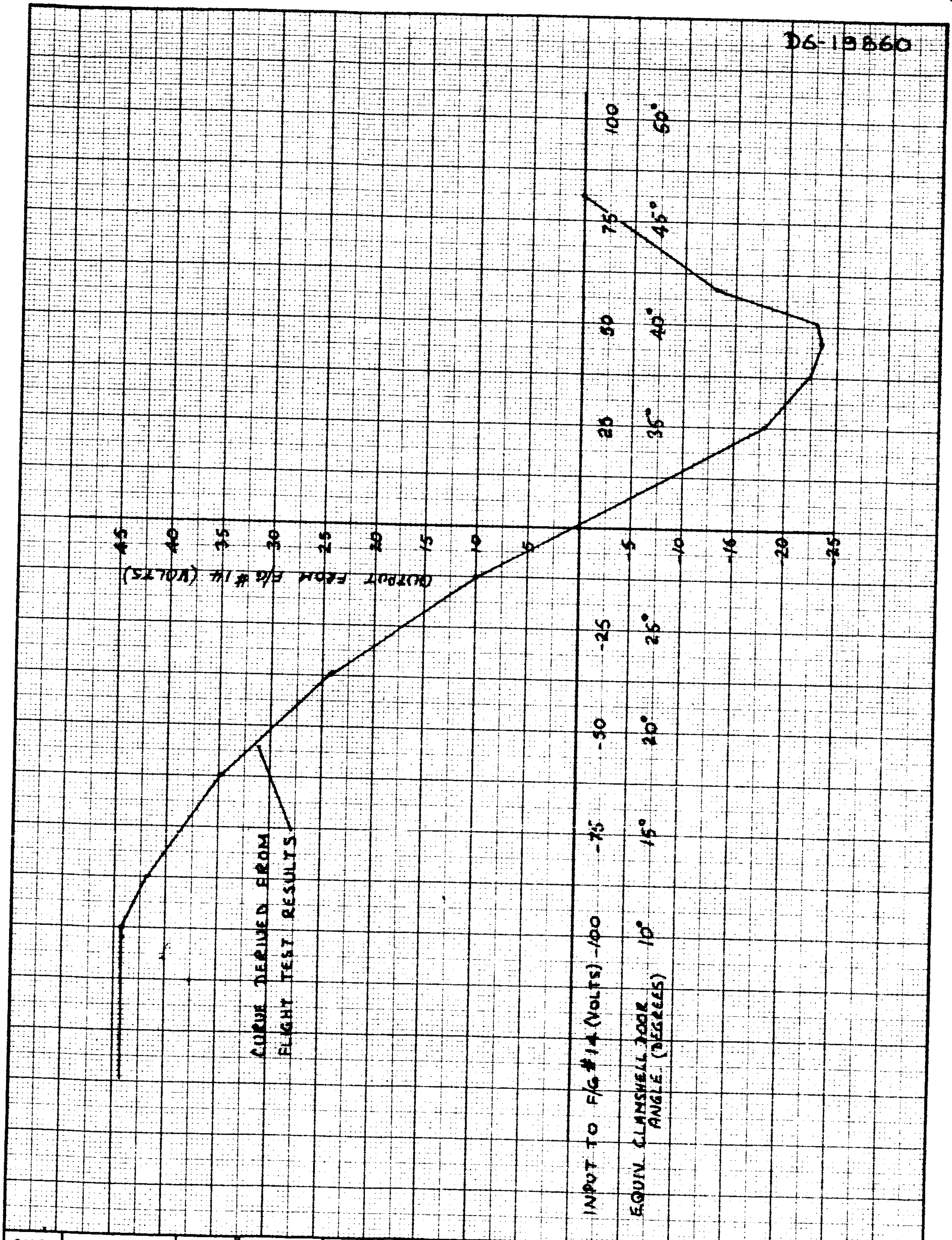
	POTENTIOMETER NO.	SETTING	TO	VARIABLE	CALCULATED FROM
ROLL	106	.0061	A82	$-10\dot{\beta}$	$-\delta w_{\dot{\beta}}\ (.2) = -(-.0305)(.2) = .0061$
	107	.4400	A82	$-R$	$-\delta w_R\ (2) = -(-.2186)(2) = .4372$
	108	.3105	A82	$+.5P$	$+\delta w_p\ (4) = .0776 \times 4 = .3105$
	111	$.5562^{.5}$	A81	-5β	$+\delta w_\beta\ (.2) = 1.391 \times .2 = .2782$
	112	$.1525^{.5}$	A81	$-\delta_W$	$+\delta w_{\delta_W}$ $= .7623$
	114	.0504	A82	$+\delta_R$	$+\delta w_{\delta_R}\ (2) = .0252 \times 2 = .0504$
	115	$.0543^{.5}$	A81	$+10\delta_{r_c}$	$-\delta w_{\delta_r}\ (.1) = -(-.2715) \times .1 = .0272$
	117	$.005^{.5}$	A81	$-10\delta_{R_{pulse}}$	$+\delta w_{\delta_R}\ (.1) = .0252 \times .1 = .0025$
	84		TRIM K ST		ROLL CONTROL EFFECTIVENESS
YAW	118	$.1152^{10}$	A83	$-10\dot{\beta}$	$-\delta r_{\dot{\beta}} = -(-1.1516) = 1.1516$
	119	$.6105^{20}$	A84	$+.5P$	$-\delta r_p\ (20) = -(-.6096) \times 20 = 12.19$
	120	$.1610^{10}$	A83	$-R$	$-\delta r_R\ (10) = -(-.1610) \times 10 = 1.610$
	121	.5852	A84	-5β	$+\delta r_\beta\ (2) = .2921 \times 2 = .5842$
	122	$.4634^{10}$	A84	$+\delta_R$	$-[\delta r_{\delta_R}\ (10) - 10] = -[(.5366)(10) - 10] = 4.634$
	123	.0911	A83	$+\delta_W$	$+\delta r_{\delta_W}\ (10) = .0091 \times 10 = .091$
	124	.1280	A83	$+\delta_{W_c}$	$+\delta r_{\delta_w}\ (10) = .0128 \times 10 = .128$
	125	.5366	A84	$-10\delta_{R_{PULSE}}$	$+\delta r_{\delta_R} = .5366$

POT.	SETTING		POT.	SETTING		POT.	SETTING	
1			51	.1124		101	.4468	
2			52			102	.1843	
3			53	.2595		103	.1841	
4			54	0.0		104	.0184	
5			55	.0150		105	.1861	
6	.3333 10		56	.2272		106	.0061	
7	.1000 10		57	.0634		107	.4372	
8	.1000		58	.8273		108	.3105	
9	.2740		59	.5000 20		109	.8150	
10			60	.5300		110	.0500	
11			61	.1845		111	.5562 ±5	
12	.8000 20		62	.2620		112	.1525 5	
13	.530 10		63	.6957		113	.2660	(dial) $\dot{\delta}_w$ limit
14	.2961		64	.1679 10		114	.0504	
15	.7700		65	.1135		115	.0543 ±5	
16	.1845 10		66	.7184		116	.2660	(dial) $\dot{\delta}_w$ limit
17	.2961		67	.2284		117	.0050 ±5	
18			68	.1800		118	.1152 10	
19			69			119	.6096 20	
20			70	.1757 10		120	.1610 10	
21			71	.1000		121	.5842	
22	.1177 10		72	.1877 10		122	.4634 10	
23	.0544 10		73	.1500		123	.0911	
24	.2005		74	.8238		124	.1280	
25	.3545		75	.2500		125	.5366	
26	.8000		76	0.0				
27	.1000		77	+40V limit on A52 (.255 dial)				
28	.0347		78					
29	.2725 10		79	.5732				
30	.0700		80					
31	.2700		81	.1656				
32	.4000		82	.0766 10				
33	.1191		83	.2961				
34	.0384		84					
35	.5052		85	.3244 10				
36	.0179		86	.4150	(dial) δ_w limit			
37	.0150		87	.3000 10				
38	.4076 10		88	.5822				
39	.4000		89	.4150	(dial) δ_w limit			
40	.0500		90	.6970				
41	.1600		91	.0166				
42	.0704		92	.1627				
43	.0128		93	.4610				
44	.0575		94	.1633				
45	.7900		95	.2263				
46	.4679		96	.9229				
47	.0597		97	.9046				
48	.0395		98	.3252				
49	.0533		99	.1875				
50	0.0		100	.3767				

AMES LARGE TRANSPORT
BASIC POT. SET LIST



			REVISED	DATE	
CALC					POTENTIOMETER # 80 CALIBRATION CURVES
CHECK					
APR					THE BOEING COMPANY
APR					PAGE A27

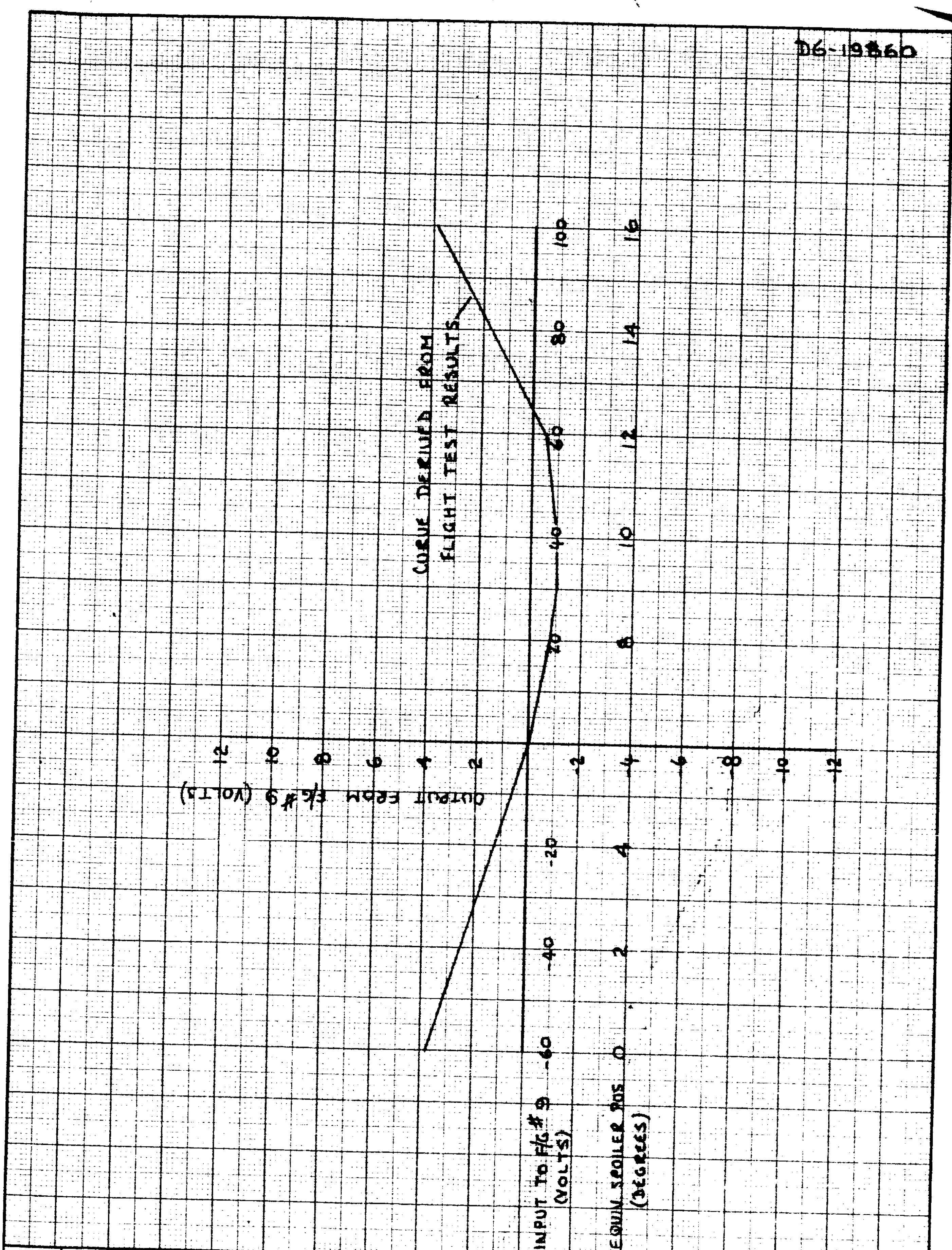


CALC			REVISED	DATE
CHECK				
APR				
APR				

FUNCTION CURVE FOR F/G #14
COMPENSATION FOR NON-LINEAR PITCHING MOMENT WITH THRUST.

THE BOEING COMPANY

TD 461 C-R4



CALC			REVISED	DATE	FUNCTION CURUE FOR F/G #9	
CHECK					COMPENSATION FOR NON-LINEAR	
APR					PITCHING MOMENT WITH SPOILERS	
APR					THE BOEING COMPANY	PAGE A29

AMES LARGE TRANSPORT

WEIGHT:	500,000 LBS
C.G. LOCATION:	.25 $\bar{c}$
ALTITUDE:	SEA LEVEL

MOMENTS OF INERTIA IN BODY AXES

I_{xx_B}	$= 17.5 \times 10^6$	SLUG FT^2
I_{yy_B}	$= 30 \times 10^6$	SLUG FT^2
I_{zz_B}	$= 45 \times 10^6$	SLUG FT^2
I_{xz_B}	$= .95 \times 10^6$	SLUG FT^2

FLIGHT CONDITION

FLAP SETTING: LANDING CONFIG.

ENGINE TIME CONSTANT: 1 SEC

GEAR: DOWN

$\frac{\Delta T}{\delta_{TH}} =$ 3,180 LB/DEG (THROTTLE)

GEOMETRY

$S = 5500$ FT^2

$\bar{c} = 28.75$ FT

$b = 215$ FT

TRIM

SPEED = 117 KTS (197.5 FT/SEC)

$\alpha_{TRIM,BODY} = 2.7°$

STABILIZER TRIM RATE = .44 $\frac{DEG}{SEC}$

$\gamma = 0.0$ DEG.

DEPENDENT VARIABLES

$q_{TRIM} = 464$ PSF

$q_{TRIM} S = 255,100$ LBS

THRUST$_{TRIM}$ = 114,787 LBS

MASS = 15,528 SLUGS

$\frac{I_{xx_B}}{qSb} = .3186$ SEC^2

$\frac{I_{yy_B}}{qS\bar{c}} = 4.089$ SEC^2

MODE SHAPES

SHORT PERIOD	$\omega_U = .939$ RAD/SEC $\omega_D = .644$ RAD/SEC $\zeta = .728$	
PHUGOID	$\omega_U = .176$ RAD/SEC $\omega_D = .174$ RAD/SEC $\zeta = .139$	
DUTCH ROLL	$\omega_U = .508$ RAD/SEC $\omega_D = .479$ RAD/SEC $\zeta = .329$ $\frac{\lvert\phi\rvert}{\lvert\beta\rvert} = 1.33$	
ROLL T.C.	= 1.14	SEC
SPIRAL DIVERG.	T.C. = 26.5 D.A = −18.3	SEC SEC

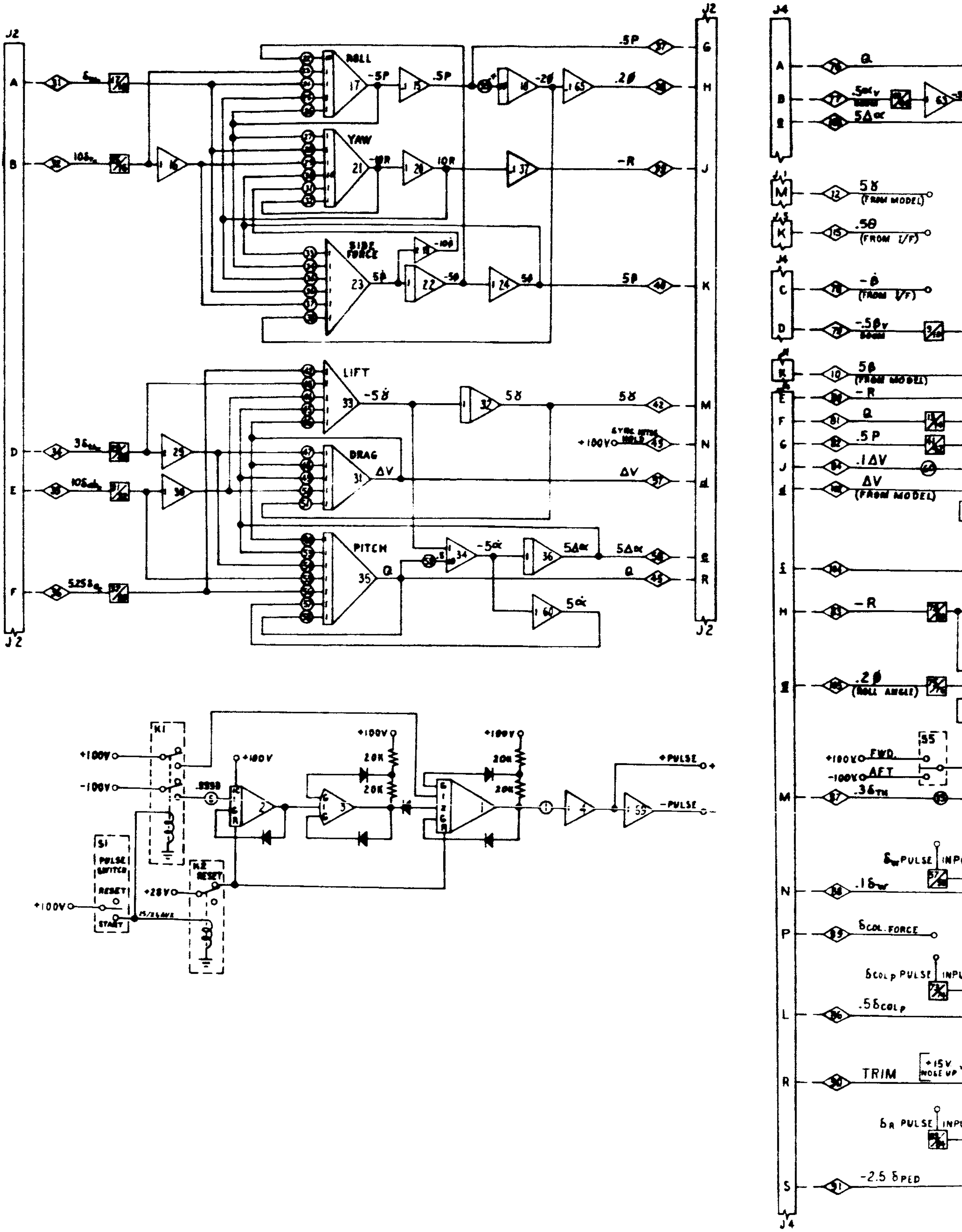
CALC.	PERSON HUANG	10-20-65	REVISED	DATE
CHECK				
APPD.				
APPD.				

VARIABLE STABILITY AIRPLANE DESCRIPTION

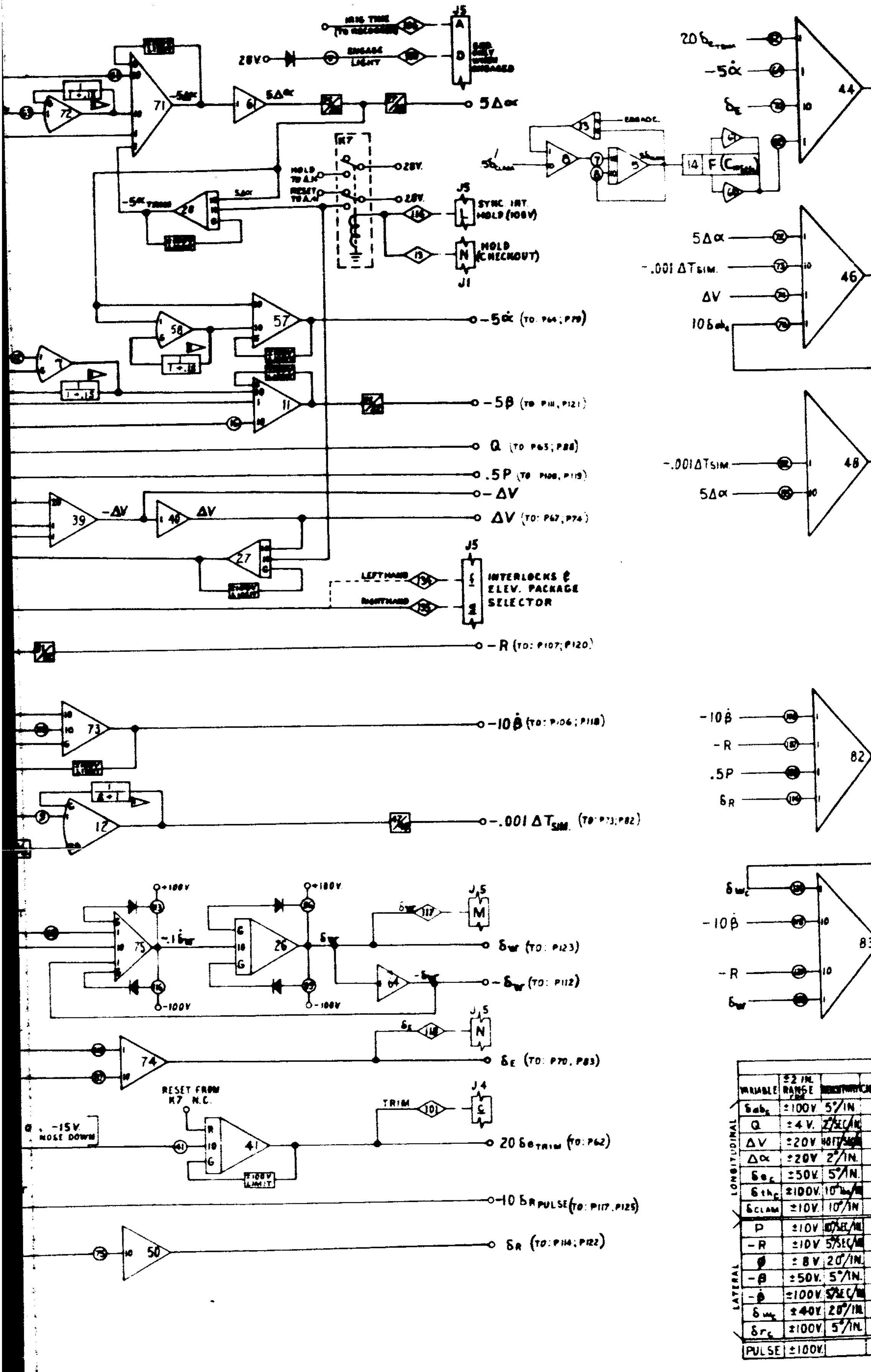
THE BOEING COMPANY
RENTON, WASH.

TD 1656-R3

Config	CONTROL & STABILITY DERIVATIVES			UNITS
CONFIG 100 (BASIC)	DRAG	$C_{D_{TRIM}}$	.45	
		C_{D_α}	1.07	/RAD
		$C_{D_{\delta E}}$	−.062	/RAD
	LIFT	$C_{L_{TRIM}}$	1.94	
		C_{L_α}	6.81	/RAD
		$C_{L_{\dot\alpha}}$	−.3959	/RAD/SEC
		C_{L_Q}	.8043	/RAD/SEC
		$C_{L_{\delta E}}$	.409	/RAD
	PITCH	C_{m_α}	−2.07	/RAD
		$C_{m_{\dot\alpha}}$	− .555	/RAD/SEC
		C_{m_Q}	−2.387	/RAD/SEC
		$C_{m_{\delta E}}$	−1.56	/RAD
	(STABILIZER)	$C_{m_{\delta S}}$	− .0545	/RAD
CONFIG 1209 (BASIC)	ROLL	C_{l_β}	−.1955	/RAD
		$C_{l_{\dot\beta}}$	−.00069	/RAD/SEC
		C_{l_P}	−.2442	/RAD/SEC
		C_{l_R}	.1955	/RAD/SEC
		$C_{l_{\delta W}}$	.0973	/RAD
		$C_{l_{\delta R}}$	.00229	/RAD
	YAW	C_{n_β}	.218	/RAD
		$C_{n_{\dot\beta}}$	.036	/RAD/SEC
		C_{n_P}	.0905	/RAD/SEC
		C_{n_R}	−.2883	/RAD/SEC
		$C_{n_{\delta W}}$	−.0001	/RAD
		$C_{n_{\delta R}}$	−.12	/RAD
	SIDE FORCE	C_{Y_β}	−.9773	/RAD
		$C_{Y_{\dot\beta}}$	−.074	/RAD/SEC
		C_{Y_P}	.06	/RAD/SEC
		C_{Y_R}	.1105	/RAD/SEC
		$C_{Y_{\delta W}}$	−.0366	/RAD
		$C_{Y_{\delta R}}$	.2464	/RAD
		C_{Y_ϕ}	1.94	/RAD

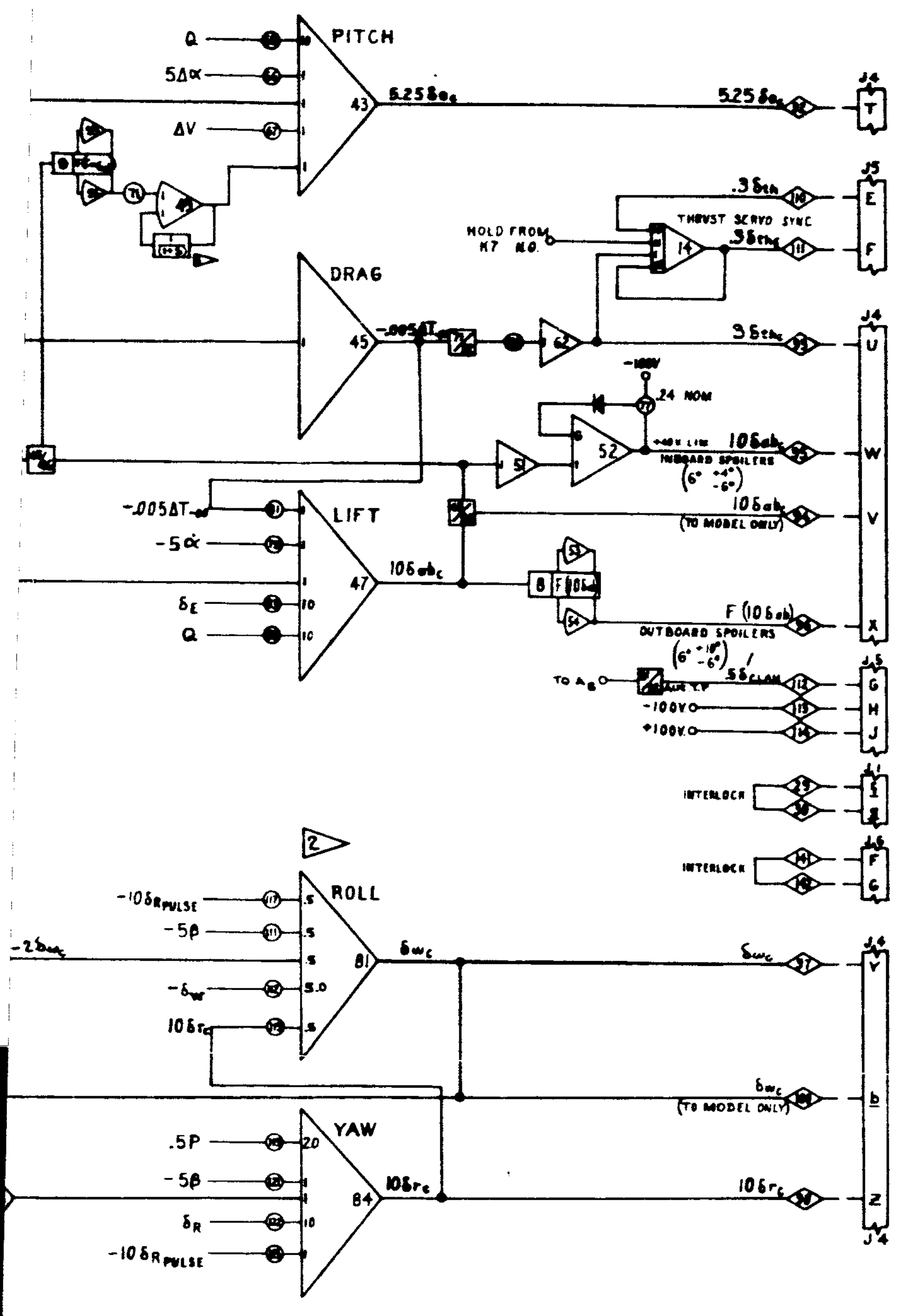

J2
ROLL
YAW
SIDE FORCE
LIFT
DRAG
PITCH
J4
(FROM MODEL)
(FROM I/F)
(ROLL ANGLE)
FWD.
AFT
S5
K1
K2
RESET
S1
PULSE SWITCH
START
+100V
-100V
+28V
20K
+PULSE
-PULSE
TRIM
PULSE
INPUT

A31-1



VARIABLE	±2 IN. RANGE	
δab_c	±100V	5°/IN.
Q	±4 V.	2°/SEC/IN.
ΔV	±20V	[illegible]
Δα	±20V	2°/IN.
δe_c	±50V	5°/IN.
δth_c	±100V	10°/IN.
δ_{CLAM}	±10V.	10°/IN.
P	±10V	10°/SEC/IN.
−R	±10V	5°/SEC/IN.
φ	± 8 V.	20°/IN.
−β	±50V.	5°/IN.
−β̇	±100V.	5°/SEC/IN.
δw_c	±40V	20°/IN.
δr_c	±100V	5°/IN.
PULSE	±100V.	

A31-2



RECORDER				
[illegible]	POTENTIOMETER		SIGNAL SOURCE	
	NUMBER	SETTING	[illegible]	[illegible]
1	91	.0166	31/32	A 47
3	93	.4610	A 35	13/14
6	96	.9229	A 31	A 40
7	97	.9046	A 36	27/28
10	100	.3767	37/38	A 43
14	104	.0184	29/30	A 62
15	105	.1861	-	[illegible]
2	92	.1627	A 15	41/42
4	94	.1633	A 37	81/82
5	95	.2263	A 65	75/76
8	98	.3252	A 22	21/22
9	99	.1875	A 19	A 73
11	101	.4468	17/18	39/40
12	102	.1843	15/16	A 84
13	103	.1841	A 4(-), A 59(-)	

1 EFFECTIVE FORWARD TRANSFER FUNCTION WHEN EXTERNAL FEEDBACK CONNECTED

2 .5 & 5 INPUT GAINS OBTAINED BY USE OF ADDITIONAL 1 MEG FEEDBACK

DRAWN	DALE E. GRAVES	10-11-65	
REVISED	DATE	REVISED	DATE
D.E.G.	11-4-65		
D.E.G.	11-10-65		
B. [illegible]	11-2[illegible]		

367-80 VARIABLE STABILITY
S.D/80 AIRBORNE COMPUTER DIAGRAM
AMES LARGE TRANSPORT
THE BOEING COMPANY
RENTON, WASHINGTON

APPENDIX B - AMES LARGE TRANSPORT VARIATIONS

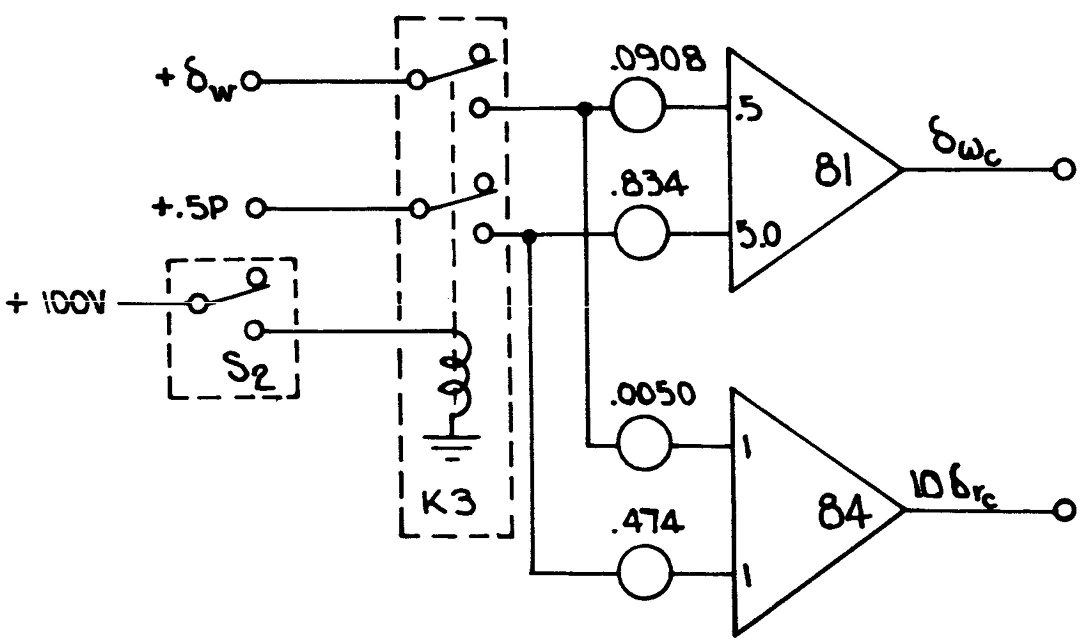
APPENDIX B AMES LARGE TRANSPORT VARIATIONS

1.0 CALCULATIONS AND CORRESPONDING AUXILIARY CIRCUITS AND POTENTIOMETER CHANGES.

1.1 LATERAL-DIRECTIONAL VARIATIONS

The Lateral-Directional variations were all obtained by changing potentiometer settings except for Configuration 1235 which employed an auxiliary circuit. This circuit, shown below, enabled additional inputs from δ_w and P to be switched into Amplifiers 81 and 84. Since the basic connections of δ_w and P into Amplifiers 81 and 84 were permanent, the auxiliary potentiometer settings were calculated to provide the difference necessary to make the required changes.

AUXILIARY CIRCUIT FOR CONFIGURATION 1235



The details of the other changes necessary to implement the Lateral-Directional variations follow:

a) Maximum Wheel Command and Maximum Wheel Rate
These maximum values were obtained by elecrical limits on the wheel command input circuit. The maximum values were set by

APPENDIX B (Continued)

a) changing the appropriate potentiometers (P113 and P116 for maximum wheel rate and P86 and P89 for maximum wheel command) to achieve the required voltage limit on the relevant amplifiers. The following table illustrates these changes:

CONFIG. NO.	REQUIRED δ_W MAX.	CORRESPONDING VOLTAGE LIMIT AMP #75	SETTING FOR POTS 113 & 116	REQUIRED δ_W MAX.	CORRESPONDING VOLTAGE LIMIT AMP #26	SETTING FOR POTS 86 & 89
1209 BASIC	375°/SEC.	37.5 V	.266 (Dial)	75°	75 V	.415 (Dial)
1203 A	150° "	15.0 "	.122 "	30°	30 "	.231 "
1207 A	150° "	15.0 "	.122 "	30°	30 "	.231 "
1235	250° "	25.0 "	.20 "	50°	50 "	.30 "
1237	66° "	6.6 "	.062 "	50°	50 "	.30 "

b) Wheel Sensitivity

The changes in wheel sensitivity were obtained by changing the value of the control derivative $C_{\ell_{\delta_W}}$ for the A.L.T. configuration.

The new values were supplied by NASA personnel and implemented in the simulation by recalculating the corresponding values of $\delta_{w_{c_{\delta_W}}}$.

It was also necessary to change the values of $\delta_{r_{c_{\delta_W}}}$ to maintain $C_{n_{\delta_W}}$ for the simulated airplane at 0.

These new values were obtained from the BLITZ Program and resulted in the following A.L.T. Matrix Potentiometer settings:

CONFIG. NO.	REQUIRED $C_{\ell_{\delta_W}}$	CORRESPONDING POT. SETTINGS	
		P 112 $\delta_{w_{\delta_W}}$	P 123 $\delta_{r_{\delta_W}}$
1209 BASIC	.0973	.1525	.0911
1203A	.1457	.2283	.1342
1207A	.0912	.1429	.0857
1235	.0915	.1525 .091*	.0911 .0052*
1237	.0915	.1434	.086

* Auxiliary Potentiometer settings

APPENDIX B (Continued)

b) Wheel Sensitivity (Continued)

The auxiliary potentiometer settings are calculated as follows:

i) $\delta\omega_{\delta w}$(Basic) = .7623

$\delta\omega_{\delta w}$(1235) = .7169

difference = $\delta\omega_{\delta w}$(1235) - $\delta\omega_{\delta w}$(Basic) = -.0454.

The output scaling is $1\delta_\omega$ and the input is $1\delta_w$.

$\therefore$ The auxiliary potentiometer setting = $\frac{.0454}{.5}$

= .0908 into a gain of .5 on Amp A81.

ii) $\delta r_{\delta w}$(Basic) = .0091

$\delta r_{\delta w}$(1235) = .0086

difference = $\delta r_{\delta w}$(1235) - $\delta r_{\delta w}$(Basic) = -.0005.

The output scaling is $10\delta r$ and the input is $1\delta_w$.

$\therefore$ The auxiliary potentiometer setting = .0005 × 10 = .005

into a gain of 1 on Amp A84.

c) Roll Time Constant

The change in roll time constant was obtained by changing the value of C_{ℓ_p} and C_{n_p} for Configuration 1235.

The new value of C_{ℓ_p} was supplied by NASA and the corresponding A.L.T. Matrix gain for $\delta\omega_p$ obtained from the BLITZ Program. This new value was implemented in the simulation by means of the auxiliary circuit described previously which provided additional inputs from P to amplifiers A81 and A84.

The new values of $\delta\omega_p$ and δr_p were obtained from the BLITZ Program and the auxiliary potentiometer settings calculated as follows:

i) $\delta\omega_p$(Basic) = .0776

$\delta\omega_p$(1235) = -2.000

difference = $\delta\omega_p$(1235) - $\delta\omega_p$(Basic) = -2.0776.

The output scaling is $1\delta_\omega$ and the input is .5P.

$\therefore$ Auxiliary potentiometer setting = $\frac{2.0776}{.5 \times 5}$

= .834 into a gain of 5 on Amp A81.

APPENDIX B (Continued)

c) Roll Time Constant (Continued)

ii) δ_{r_p}(Basic) = -.6096

δ_{r_p}(1235) = -.6333

difference = δ_{r_p}(1235) - δ_{r_p}(Basic) = -.0237.

The output scaling is 10 δr and the input is .5P.

$\therefore$ Auxiliary potentiometer setting = $\dfrac{.0237 \times 10}{.5}$

= .474 into a gain of 1 on Amp A84.

APPENDIX B (Continued)

1.2 LONGITUDINAL VARIATIONS

The longitudinal variations were implemented with a combination of basic potentiometer changes and auxiliary circuits. The variations involved changes in the values of $C_{L_{\delta_E}}$, $\delta_E/\delta_{COL.}$, $C_{m_{\delta_E}}$, C_{m_α}, and C_{m_Q} as shown in Table II, Page 58.

The new values for these derivatives were supplied by NASA and implemented in the following manner:

a) Elevator to Column Gearing ($\delta_E/\delta_{COL.}$)
The three values of $\delta_E/\delta_{COL.}$ simulated were 1.5, 3.0 and 4.5.

These changes involved a simple gain change and, since the scaling of $\delta_{COL.}$ was .5 $\delta_{COL.}$, were obtained by setting potentiometer P87 in the basic patching to .3000, .6000, and .9000, respectively, into a gain of 10 on Amp A74.

b) Lift Coefficient Due to Elevator ($C_{L\delta_E}$)
The values of $C_{L_{\delta_E}}$ simulated were +.40, 0, and -.40.

The basic value of .40 resulted in an input of δ_E through potentiometer P83 set at .2961 into a gain of 10 on Amp A47.

The $C_{L_{\delta_E}}$ of 0 was obtained by switching in an input from δ_E through an auxiliary potentiometer also set at .2961 into a gain of 10 on Amp A48. This had the effect of cancelling out the basic value.

The $C_{L_{\delta_E}}$ of -.40 was obtained by switching in an additional input of δ_E through another auxiliary potentiometer set at .2961 into a gain of 10 on Amp A48.

c) Elevator Power ($C_{m_{\delta_E}}$)
Two values of $C_{m_{\delta_E}}$ were simulated; -1.56 which was the basic value, and -2.3.

The value of -2.3 was obtained by switching in an additonal input of δ_E through an auxiliary potentiometer into Amp A44 to make up the difference. The setting of the auxiliary potentiometer was obtained as follows:

$\delta_{e_{\delta_E}}(C_{m_{\delta_E}} = -1.56)$ = .3346 from BLITZ

$\delta_{e_{\delta_E}}(C_{m_{\delta_E}} = -2.3)$ = .4827 from BLITZ

difference = .4827 - .3346 = .1481
Output scaling is 5.25 δ_e and the input is δ_E

∴ Auxiliary potentiometer setting = .1481 x 5.25 = .7971 into a gain of 1 on Amp A44.

APPENDIX B (Continued)

1.2 LONGITUDINAL VARIATIONS (Continued)

d) Pitching Moment Coefficient Due to Angle of Attack ($C_{M\alpha}$)
Three values of $C_{M\alpha}$ were simulated; -2.C which was the basic value, -4.0 and -0.5. The $C_{M\alpha}$ of -4.0 was obtained by switching an additional input into Amp A43 through an auxiliary potentiometer and the $C_{M\alpha}$ of -0.5 by switching an additional input into Amp A44 through an auxiliary potentiometer. The auxiliary potentiometer settings were calculated as follows:

i) $\delta e_{\Delta\alpha}(C_{M\alpha} = -2.0) = -.6842$ from BLITZ

$\delta e_{\Delta\alpha}(C_{M\alpha} = -4.0) = -.2701$ from BLITZ

difference = -.2701 + .6842 = +.4141
Output scaling is $5.25\,\delta e$ and input is $-5\Delta\alpha$

∴ Auxiliary potentiometer setting = $\dfrac{.4141 \times 5.25}{5}$ = .0435 into a gain of 10 on Amp A43.

ii) $\delta e_{\Delta\alpha}(C_{M\alpha} = -2.0) = -.6842$ from BLITZ

$\delta e_{\Delta\alpha}(C_{M\alpha} = -0.5) = -1.0209$ from BLITZ

difference = -1.0209 + .6842 = -3367
Output scaling is $5.25\,\delta e$ and input is $-5\Delta\alpha$

∴ Auxiliary potentiometer setting = $\dfrac{.3367 \times 5.25}{5}$ = .0354 into a gain of 10 on Amp A44.

e) Pitching Moment Coefficient Due to Pitch Rate (C_{MQ})
Two values of C_{MQ} were simulated; -2.4 which was the basic value, and -4.8

The C_{MQ} of -4.8 was obtained by switching an additional input from Q into Amp A44 through an auxiliary potentiometer. The setting of this potentiometer was calculated from:

$\delta e_Q (C_{MQ} = -2.4) = -.2162$ from BLITZ

$\delta e_Q (C_{MQ} = -4.8) = .3015$ from BLITZ

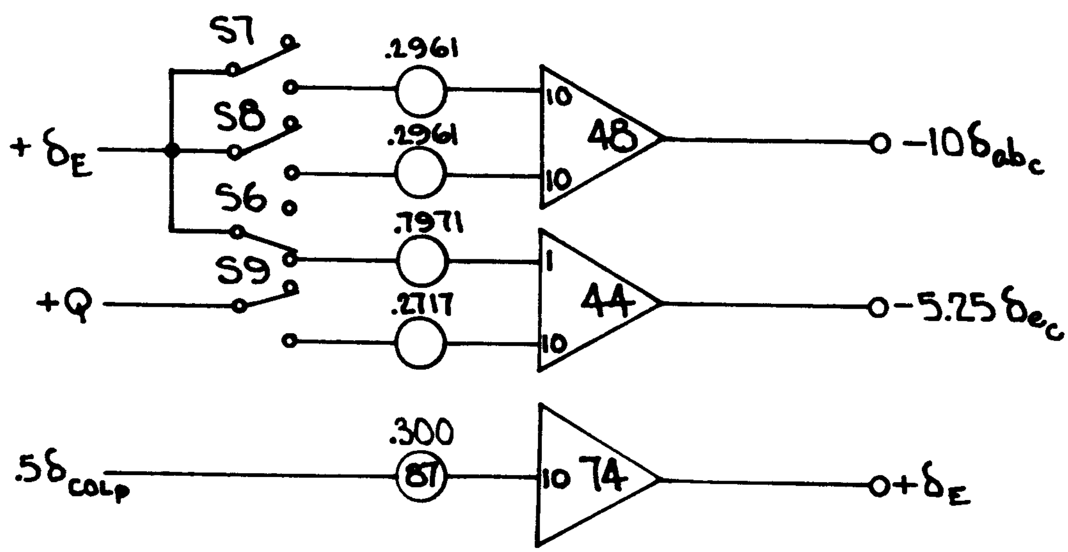
difference = .3015 + .2162 = .5187
Output scaling is $5.25\,\delta e$ and input is Q

∴ Auxiliary potentiometer setting = .5187 x 5.25 = .2718 into a gain of 10 on Amp A44.

The following figures show the two auxiliary circuits as they were set up to effect these changes:

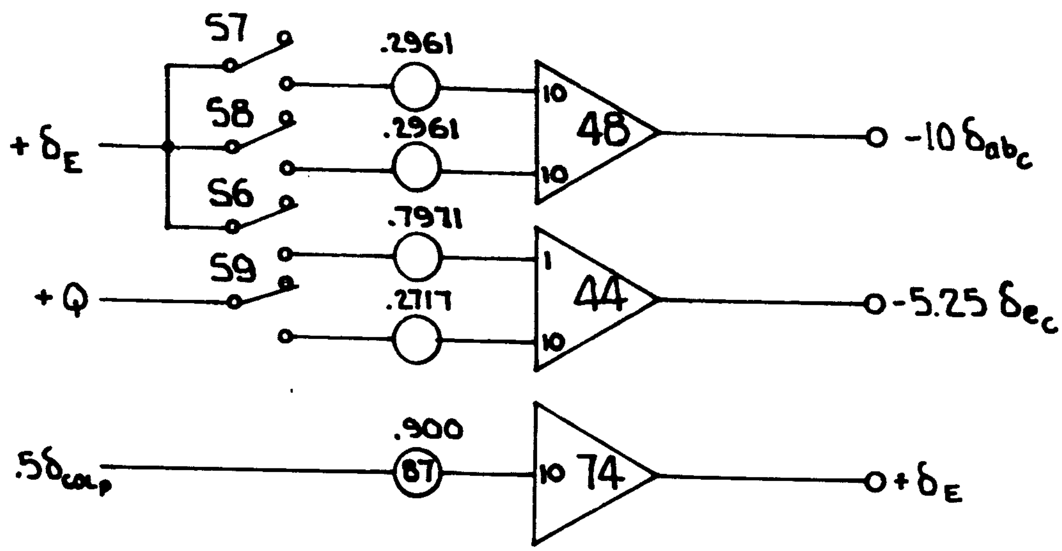
AUX. CKT. #1

CONFIG. 101A



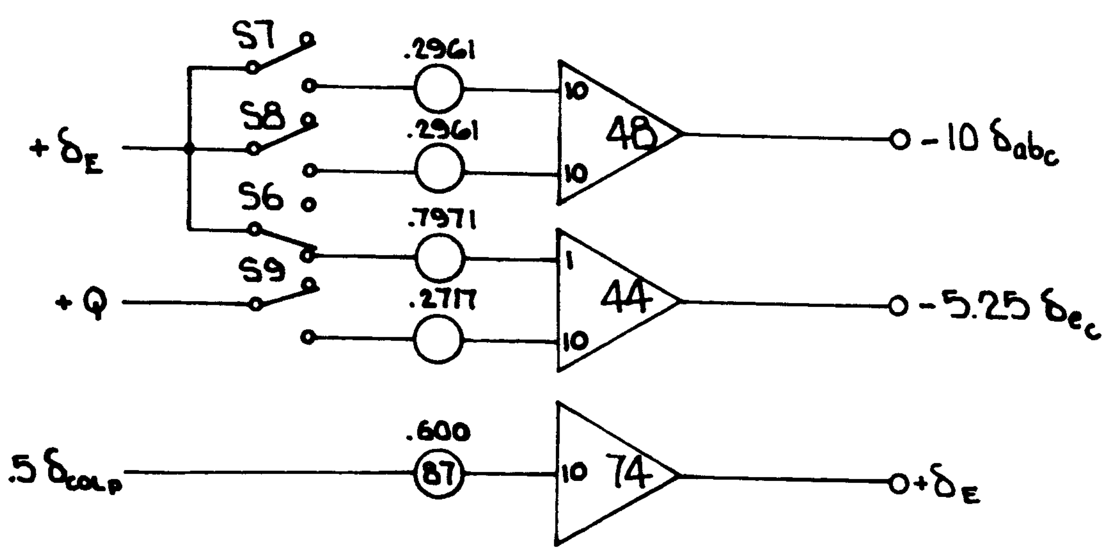
AUX. CKT. #1

CONFIG. 105*



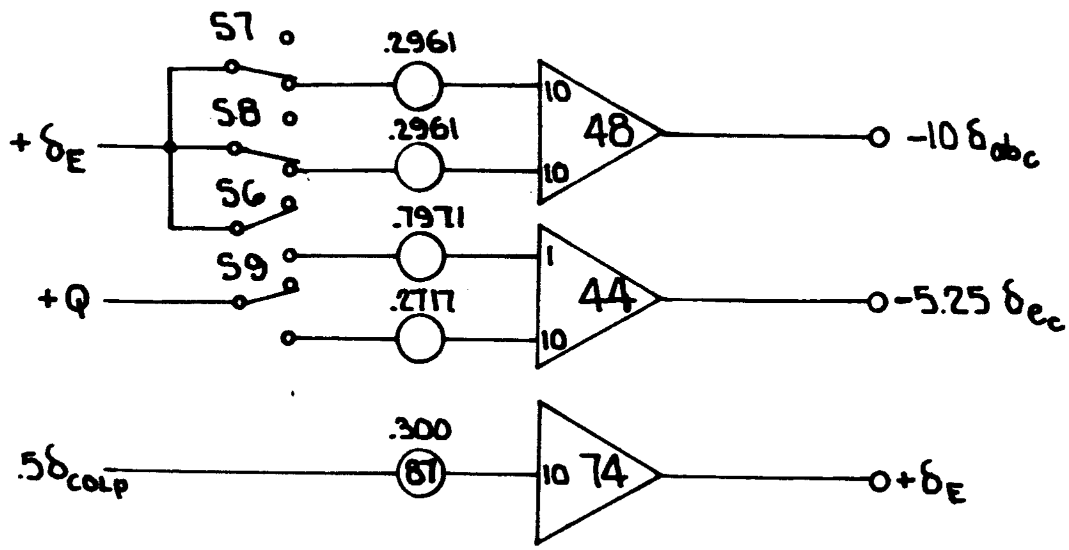
AUX. CKT. #1

CONFIG. 105A



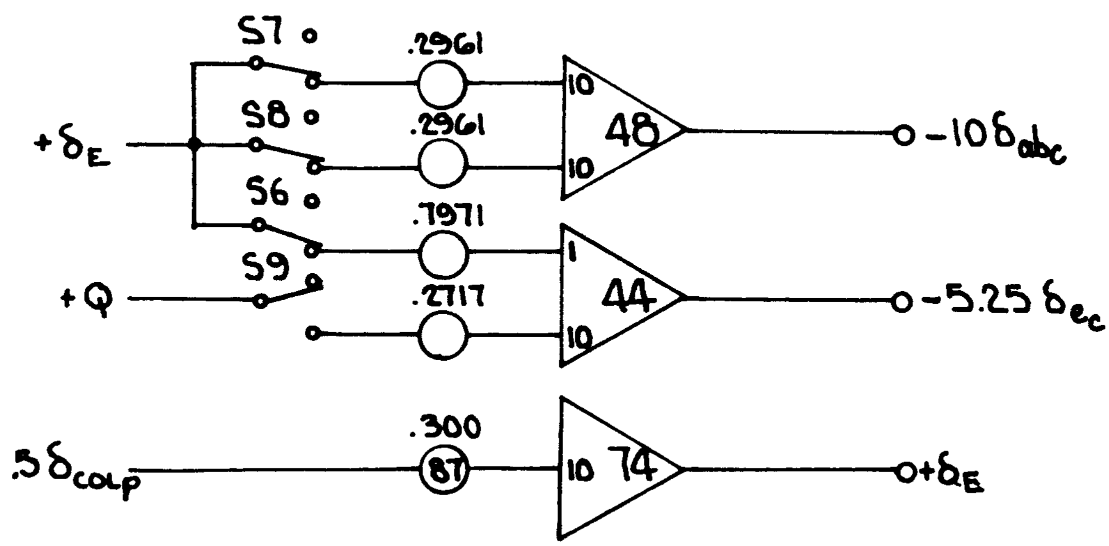
AUX. CKT. #1

CONFIG. 151



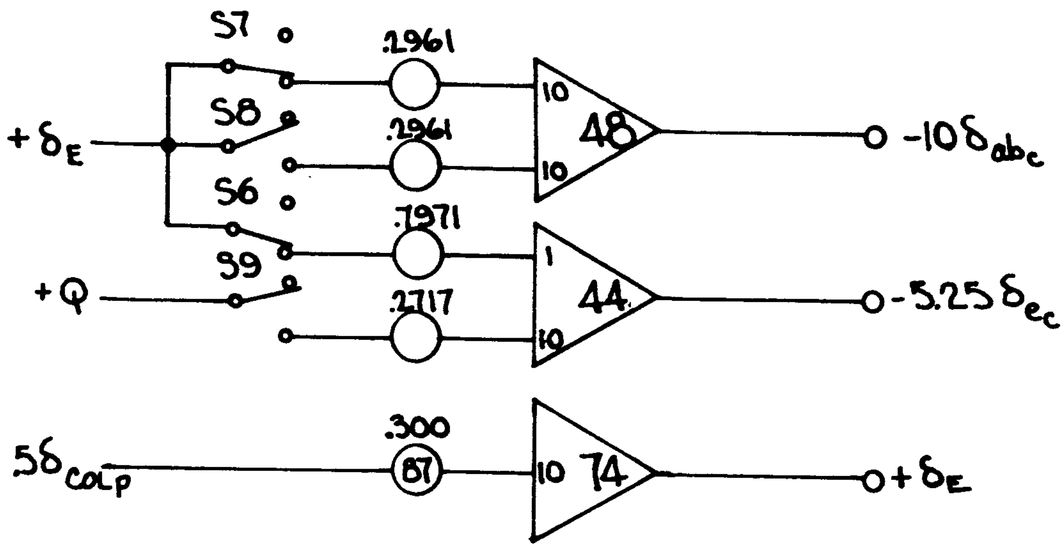
AUX. CKT. #1

CONFIG. 151B



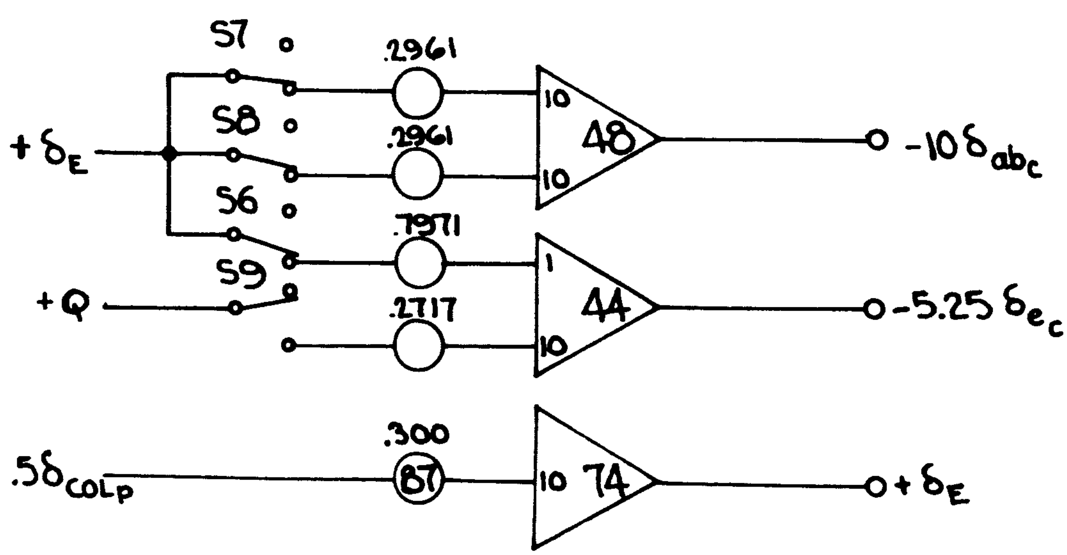
AUX. CKT. #1

CONFIG. 151C



AUX. CKT. #1

CONFIG. 151D

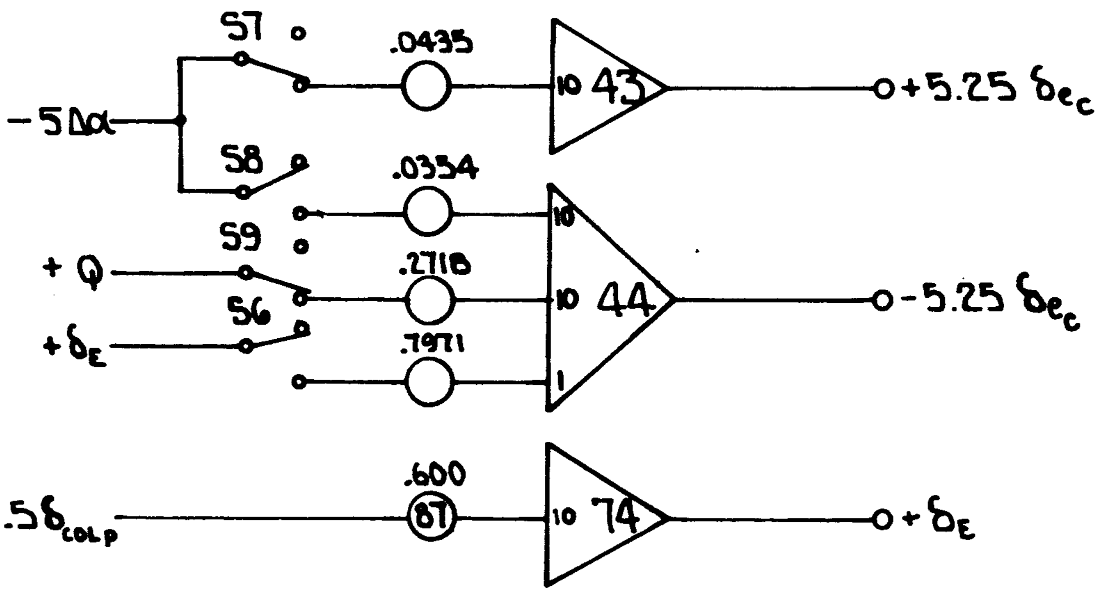


101

AD 4572

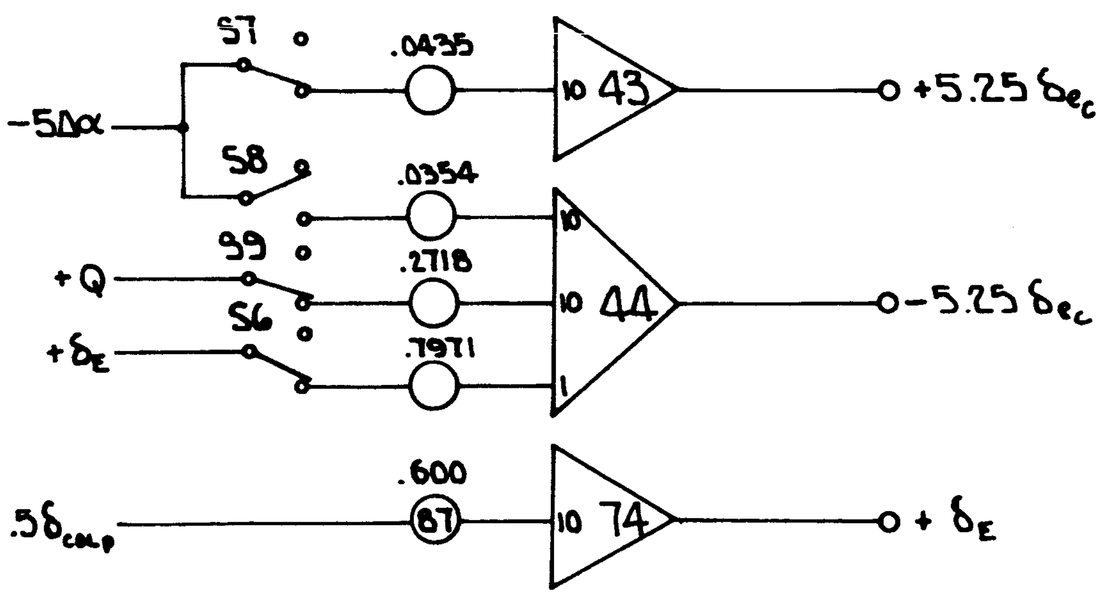
CONFIG. 158

AUX. CKT. #2



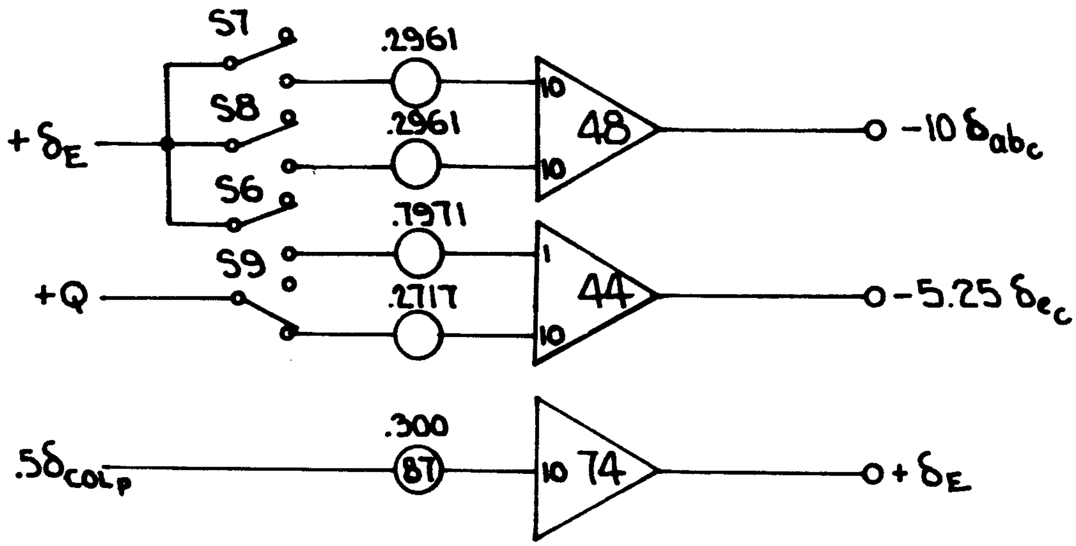
AUX. CKT. #2

CONFIG. 158A



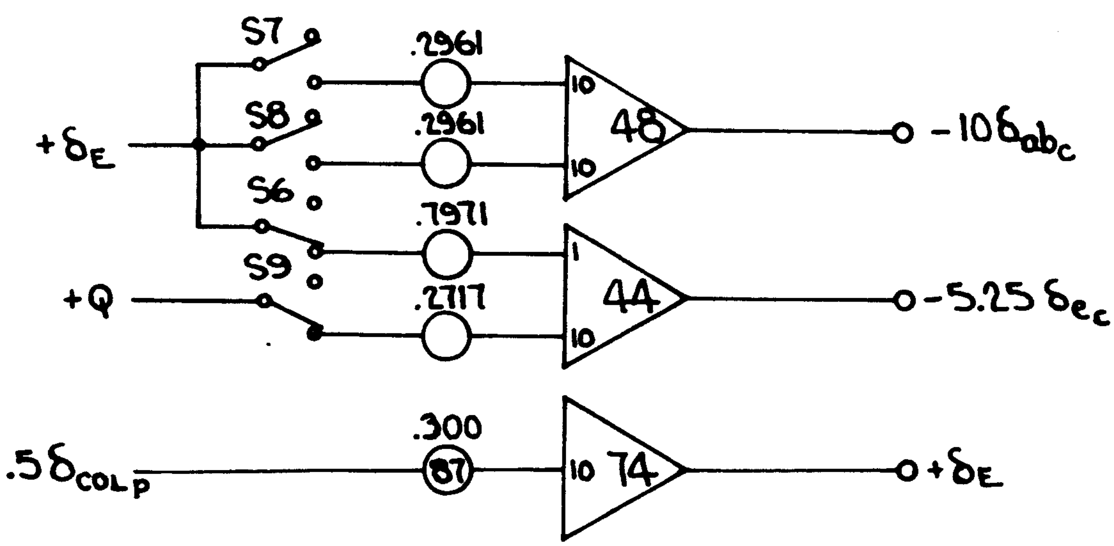
AUX. CKT. #1

CONFIG. 159



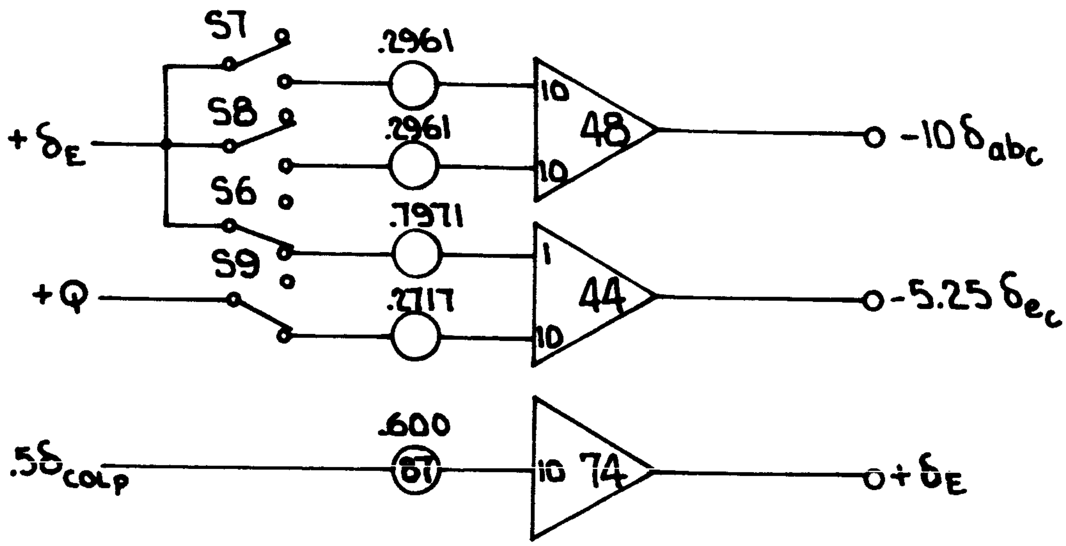
AUX. CKT. #1

CONFIG. 159A



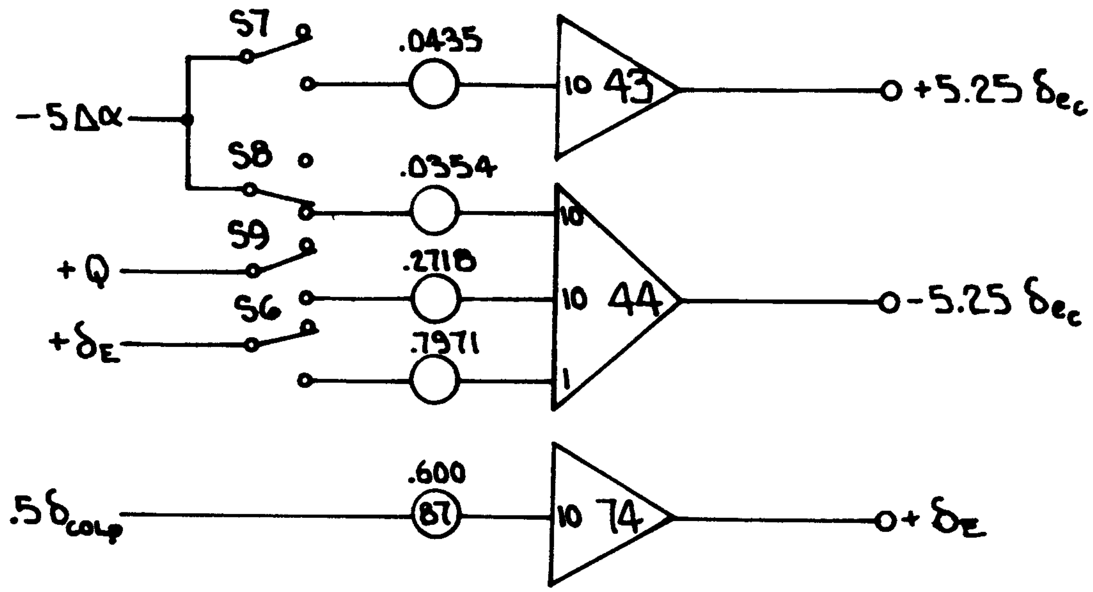
AUX. CKT. #1

CONFIG. 159B



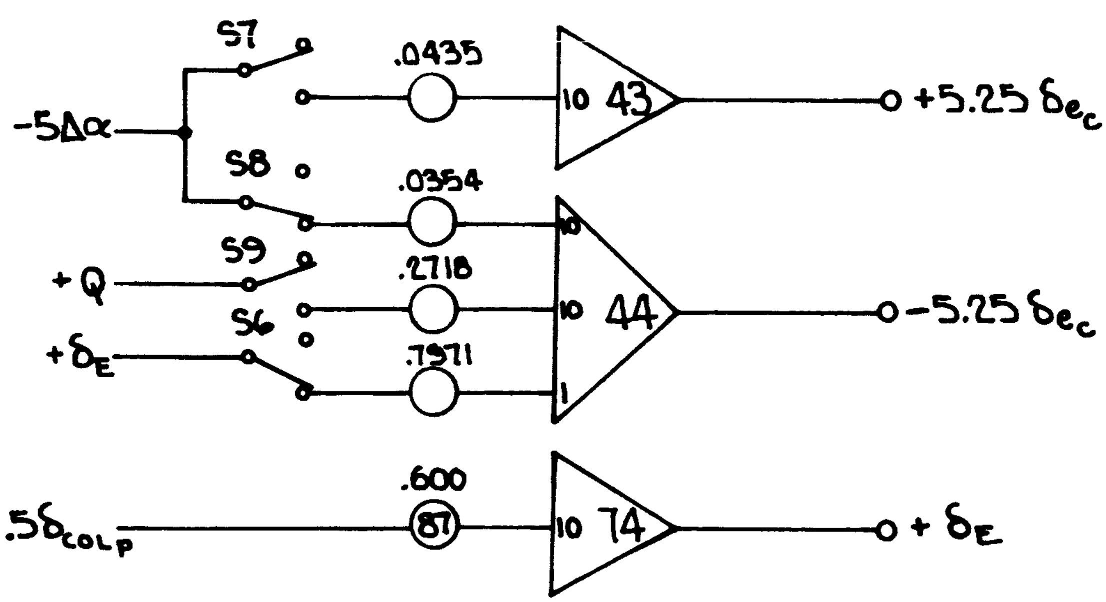
CONFIG. 161

AUX. CKT. #2



CONFIG. 161B

AUX. CKT. #2



APPENDIX B (Continued)

2.0 BLITZ PROGRAM RESULTS

The following section contains the BLITZ Program results that were used for the simulation and an explanation of the BLITZ sheets.

2.1 EXPLANATION OF BLITZ SHEETS

Each configuration has two BLITZ sheets. The first sheet contains the primary inputs to the program and the results of the intermediate calculations. Tables B1 and B2 give the correlation between the symbols used in the text and the symbols used on the BLITZ sheets.

Since the BLITZ Program was designed to be versatile, the BLITZ sheets contain many symbols which are either not applicable or have a numerical value of zero. These symbols have been omitted from Tables B1 and B2. The second BLITZ sheet contains additional inputs such as the scale factors of the variables and are self-explanatory (e.g., KDA is the scale factor for $\Delta\alpha$). It also contains a duplicate list of the unscaled A.L.T. Matrix gains which are used as inputs for the final set of calculations.

The last list on the second sheet contains the scaled A.L.T. Matrix gains arranged opposite the potentiometer number which is used to achieve this gain and the amplifier which it feeds (e.g., P64A44 means Potentiometer 64 feeding Amplifier 44). It should be noted that the value given is the product of the potentiometer setting and the input gain that is used for that particular input.

It should further be noted that the gains of the inputs to Amplifier 81 were calculated for an output of $2\delta_\omega$, whereas the computer was actually mechanized for δ_ω so the numbers used were half those given on the BLITZ sheet.

All the numerical values are given in a base number multiplied by 10 raised to some power (e.g., 1.500000E 05 = 1.5×10^5 = 150,000. or -7.4900000E-02 = -7.49×10^{-2} = -.0749).

The first line on each sheet gives the date, reference axis (body or stability), longitudinal configuration, lateral-directional configuration and page number which is irrelevant for the purpose of this document and can be ignored.

The following examples illustrate the interpretation of this information:

- Date - This is the date on which the BLITZ run was made (e.g., 1.21065E 01 = 12/10/65).
- AMESLT 1.200000E 00 is a code for the axis in which the calculation is made (e.g., 1.100000E 00 means body axis and 1.200000E 00 means stability axis).

APPENDIX B (Continued)

2.1 EXPLANATION OF BLITZ SHEETS (Continued)

- LONGAX 1.011000E 02 is a code for the longitudinal configuration number. The first three digits correspond to the number and the fourth digit is a numerical representation of a letter (e.g., 1.01100E 02 means Configuration 101A and 1.232000E 02 means Configuration 123B).

- LADIAX 1.209000E 02 is a similar code for the lateral directional configuration number (e.g., 1.209000E 03 means Configuration 1209 and 1.207100E 03 means Configuration 1207A).

2.2 BLITZ OUTPUT SHEETS FOR VARIATIONS SIMULATED

The following BLITZ output sheets contain values for both the longitudinal and lateral-directional axes.

The sheets showing the lateral-directional variations all have the same longitudinal values (Long. 101A) and the sheets showing the longitudinal variations all have the same lateral-directional values (Lat. 1209). On every sheet the values that vary from the basic are underlined. Those longitudinal sheets that have two longitudinal variations (e.g., 101A and 105A) are valid for both the variations, the only difference between the two being the elevator to column gearing $\delta_E/\delta_{COL.}$ which does not show up on the BLITZ output.

TABLE B1

SYMBOL IN TEXT	UNITS	SYMBOLS IN BLITZ: 367-80 Airplane	SYMBOLS IN BLITZ: Simulated Airplane
mg	lb.	MG8	MGS
α TRIM (Body)	Degrees	ATR8	ATRS
THRUST TRIM	lb.	THTR8	THTRS
Ixx	Slugs Ft^2	IXX8	IXXS
Iyy	"	IYY8	IYYS
Izz	"	IZZ8	IZZS
Ixz	"	IXZ8	IXZS
q TRIM	16/Ft^2	QTR8	QTRS
V TRIM	Ft/Sec	VTR8	VTRS
S	Ft^2	S8	SS
b	Ft	B8	BS
$\bar{c}$	Ft	C8	CS
C_D TRIM		CDTR8	CDTRS
C_{D_α}	/RAD	CDA8	CDAS
$C_{D_{\delta_E}}$	/RAD	--	CDDES
C_L TRIM		CLTR8	CLTRS
C_{L_α}	/RAD	CLA8	CLAS
$C_{L_{\dot\alpha}}$	/RAD/SEC	--	CLADS
C_{L_q}	/RAD/SEC	--	CLQS
$C_{L_{\delta_e}}$	/RAD	CLDE8	--
$C_{L_{\delta_E}}$	/RAD	--	CLDES
$C_{L_{\delta_{ab}}}$	/RAD	CLDAB	--
C_{m_α}	/RAD	CMA8	CMAS
$C_{m_{\dot\alpha}}$	/RAD/SEC	CMAD8	CMADS
$C_{m_{\Delta V}}$	/FT/SEC	CMDV8	--
$C_{m_{\delta_e}}$	/RAD	CMDE8	--
$C_{m_{\delta_E}}$	/RAD	--	CMDES
$C_{m_{\delta_{ab}}}$	/RAD	CMDAB	--
C_{m_q}	/RAD/SEC	CMQ8	CMQS

SYMBOL IN TEXT	UNITS	SYMBOLS IN BLITZ: 367-80 Airplane	SYMBOLS IN BLITZ: Simulated Airplane
C_{l_β}	/RAD	CLB8	CLBS
$C_{l_{\dot\beta}}$	/RAD/SEC	--	CLBDS
C_{l_p}	/RAD/SEC	CLP8	CLPS
C_{l_R}	/RAD/SEC	CLR8	CLRS
$C_{l_{\delta_\omega}}$	/RAD	CLDW8	--
$C_{l_{\delta_W}}$	/RAD	--	CLDWS
$C_{l_{\delta_r}}$	/RAD	CLDR8	--
$C_{l_{\delta_R}}$	/RAD	--	CLDRS
C_{n_β}	/RAD	CNB8	CNBS
$C_{n_{\dot\beta}}$	/RAD/SEC	CNBD8	CNBDS
C_{n_p}	/RAD/SEC	CNP8	CNPS
C_{n_R}	/RAD/SEC	CNR8	CNRS
$C_{n_{\delta_\omega}}$	/RAD	CNDW8	--
$C_{n_{\delta_W}}$	/RAD	--	CNDWS
$C_{n_{\delta_r}}$	/RAD	CNDR8	--
$C_{n_{\delta_R}}$	/RAD	--	CNDRS
C_{Y_β}	/RAD	CYB8	CYBS
$C_{Y_{\dot\beta}}$	/RAD/SEC	--	CYBDS
C_{Y_p}	/RAD/SEC	CYP8	CYPS
C_{Y_R}	/RAD/SEC	CYR8	CYRS
$C_{Y_{\delta_\omega}}$	/RAD	CYDW8	
$C_{Y_{\delta_W}}$	/RAD	--	CYDWS
$C_{Y_{\delta_r}}$	/RAD	CYDR8	--
$C_{Y_{\delta_R}}$	/RAD	--	CYDRS

TABLE B1

Key to Blitz Symbols

(Inputs to Program)

TABLE B2

SYMBOL IN TEXT	UNITS	SYMBOLS IN BLITZ 367-80 Airplane	SYMBOLS IN BLITZ Simulated Airplane
$\mathrm{SIN}\,\alpha$		SINA8	SINAS
$\mathrm{COS}\,\alpha$		COSA8	COSAS
I'_{xx}	Slugs ft^2	IXXP8	IXXPS
I'_{zz}	"	IZZP8	IZZPS
I'_{xz}	"	IXZP8	IXZPS
$q \cdot S\bar{c}/I_{YY}$		KPIT8	KPITS
$q \cdot Sb \Big/ \left(I'_{xx} - \frac{I'^2_{xz}}{I'_{zz}}\right)$		KROL8	KROLS
$q \cdot Sb \Big/ \left(I'_{zz} - \frac{I'^2_{xz}}{I'_{xx}}\right)$		KYAW8	KYAWS
$q \cdot S/m$		KDLS8	KDLSS
K_{PITCH}		KPITCH	
K_{ROLL}		KROLL	
K_{YAW}		KYAW	
$K_{LIFT,\,DRAG}$		KDLS	

SYMBOL IN TEXT	SYMBOLS IN BLITZ A.L.T. MATRIX GAINS (Unscaled)
$\delta e_{\delta ab}$	DE8DAB
$\delta\omega_{\beta}$	DW8B
$\delta\omega_{\dot{\beta}}$	DW8BD
$\delta\omega_{p}$	DW8P
$\delta\omega_{R}$	DW8R
$\delta\omega_{\delta W}$	DW8DWS
$\delta\omega_{\delta R}$	DW8DRS
$\delta\omega_{\delta r}$	DW8DR8
δr_{β}	DR8B
$\delta r_{\dot{\beta}}$	DR8BD
δr_{p}	DR8P
$\delta r_{\delta W}$	DR8DWS
$\delta r_{\delta R}$	DR8DRS
$\delta r_{\delta\omega}$	DR8DW8

SYMBOL IN TEXT		SYMBOLS IN BLITZ A.L.T. MATRIX GAINS (Unscaled)
$\Delta T\text{-}80_{\Delta\alpha}$		DT8DA
$\Delta T\text{-}80_{\Delta V}$		DT8DV
$\Delta T\text{-}80_{\Delta T_{A.L.T.}}$		DT8DTS
$\delta ab_{\Delta\alpha}$		DABDA
$\delta ab_{\delta E}$		DABDES
$\delta ab_{\Delta T_{A.L.T.}}$		DABDTS
$\delta ab_{\Delta T\text{-}80}$		DABDT8
$\delta ab_{\dot{\alpha}}$		DABAD
δab_{Q}		DABQ
$\delta e_{\Delta\alpha}$		DE8DA
$\delta e_{\dot{\alpha}}$		DE8AD
δe_{Q}		DE8Q
$\delta e_{\Delta V}$		DE8DV
$\delta a_{\delta E}$		DE8DES

TABLE B 2

Key to Blitz Symbols

(Outputs from Program)

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LAT. CONFIG. # 1203A

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.203100E 03	PAGE	1.000100E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.250000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	1.457000E-01
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DA8DES	-2.960689E-01	DA8DE8	6.435643E-01	DA8DTS	-7.658657E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	1.141534E 00
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	1.342356E-02
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCY8D	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LAT. CONFIG. #1203A

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.203100E 03	PAGE	2.000100E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DA8DES	-2.960689E-01	DA8DE8	6.435643E-01	DA8DTS	-7.658660E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW88	1.390618E 00	DW88D	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	1.141534E 00
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR88	2.921084E-01	DR88D	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	1.342356E-02
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.533961E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	2.283068E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	1.342356E-01
P124A3	6.376025E-02

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LAT. CONFIG. # 1207A

DATE	1.210650E 01	AMESLT	1.200000E 00	LCNGAX	1.011000E 02	LADIAX	1.207100E 03	PAGE	1.000200E 00		
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06		
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03		
B8	1.308000E 02	C8	2.010000E 01								
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.		
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.		
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.		
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01				
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02		
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01		
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01		
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01						
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07		
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03		
BS	2.150000E 02	CS	2.975000E 01								
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02		
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01		
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.		
CMDVS	0.	CMDES	-2.250000E 00	CMDFS	0.	CMQS	-2.387000E 00				
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.120000E-02		
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01		
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02		
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01						
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04		
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05		
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01				
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01				
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01				
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.				
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06		
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01						
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01		
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.				
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.145380E-01		
CW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02						
DR8B	2.521084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	8.569597E-03		
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02						
DCY8	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04		
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03						

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LAT. CONFIG. # 1207A

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.207100E 03	PAGE	2.000200E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDTB	-5.000000E-03	KDAB	1.000000E 01	KDEB	5.250000E 00	KDWB	2.000000E 00	KDRB	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DFBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDFS	-7.658660E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DEBDA	-6.841587E-01	DEBAD	-1.599184E-01	DEBQ	-2.161574E-01	DEBDV	-4.384185E-02	DEBDES	4.826592E-01
DEBDTS	-0.	DEBDTB	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.145380E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01						
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	8.569597E-03
DRBDRS	5.366130E-01	DRBDWB	1.275205E-02						
P64A44	1.679143E-01								
P65A43	1.134826E 00								
P66A43	7.183666E-01								
P67A43	2.301697E-01								
P68A44	0.								
P69A43	6.946154E-02								
P70A44	2.533961E 00								
P72A46	1.869572E-01								
P73A46	1.500000E 00								
P74A46	8.231735E-01								
P76A46	-0.								
P79A47	5.731720E-01								
P80A48	0.								
P81A47	1.607372E-01								
P82A48	7.658660E-02								
P83A47	2.960689E 00								
P85A48	3.244436E 00								
P88A47	5.822206E 00								
P106A2	6.094950E-03								
P107A2	4.371610E-01								
P108A2	3.104758E-01								
P111A1	5.562472E-01								
P112A1	1.429076E 00								
P114A2	5.042006E-02								
P115A1	5.430222E-02								
P118A3	1.151619E 00								
P119A4	1.219217E 01								
P120A3	1.610243E 00								
P121A4	5.842168E-01								
P122A4	4.633850E 00								
P123A3	8.569597E-02								
P124A3	6.376025E-02								

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LAT. CONFIG. # 1235

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.235000E 03	PAGE	1.000000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.250000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-5.100000E-01	CLRS	1.955000E-01	CLDWS	9.150000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	CABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	-2.004866E 00	DW8R	-2.185805E-01	DW8DWS	7.168884E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.332817E-01	DR8R	-1.610243E-01	DR8DWS	8.596316E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LAT. CONFIG. # 1235

DATE	1.210650E 01	AMESLF	1.200000E 00	LONGAX	8.011000E 02	LADIAX	1.235000E 03	PAGE	2.000300E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DA8DES	-2.960689E-01	DA8DE8	6.435643E-01	DA8DTS	-7.658660E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW88	1.390618E 00	DW88D	-3.047475E-02	DW8P	-2.004866E 00	DW8R	-2.185805E-01	DW8DWS	7.168884E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR88	2.921084E-01	DR88D	-1.151619E 00	DR8P	-6.332817E-01	DR8R	-1.610243E-01	DR8DWS	8.596316E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.546154E-02
P70A44	2.533961E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A1	8.019464E 00
P111A1	5.562472E-01
P112A1	1.433777E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.266563E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	8.596316E-02
P124A3	6.376025E-02

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LAT. CONFIG. # 1237

DATE	1.210650E 01	AMFSLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.237000E 03	PAGE	1.000400E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.250000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.150000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	CABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DEBDA	-6.841587E-01	DEBAD	-1.599184E-01	DEBQ	-2.161574E-01	DEBDV	-4.384185E-02	DEBDES	4.826592E-01
DEBDTS	-0.	DEBDT8	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.168884E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01	CLDWPB	5.994490E-02				
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	8.596316E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02	CNDRPB	-7.540621E-02				
DCYB	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDWB	4.397906E-04	DCYDRB	-3.682373E-03				

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LAT. CONFIG. # 1237

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.237000E 03	PAGE	2.000400E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDAB	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.168884E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	8.596316E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.533961E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.433777E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	8.596316E-02
P124A3	6.376025E-02

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LONG. CONFIG. # 101A & 105A

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.209000E 03	PAGE	1.040000E 00
MGB	1.500000E 05	ATRB	6.500000E 00	THTRB	1.819400E 04	IXXB	2.570000E 06	IYYB	2.250000E 06
IZZB	4.730000E 06	IXZB	1.600000E 05	QTRB	4.640000E 01	VTRB	1.975000E 02	SB	2.821000E 03
BB	1.308000E 02	CB	2.010000E 01						
CDTRB	1.390000E-01	CDAB	5.440000E-01	CDDTB	0.	CDDVB	0.	CDDEB	0.
CDDAB	0.	CLTRB	1.124200E 00	CLAB	5.418000E 00	CLDTB	0.	CLDVB	0.
CLDEB	5.200000E-01	CLDAB	-8.080000E-01	CMAB	-1.100000E 00	CMADB	-2.720000E-01	CMDTB	0.
CMDVB	-7.460000E-04	CMDEB	-9.750000E-01	CMDAB	-1.290000E-01	CMQB	-7.100000E-01		
CLBB	-1.743000E-01	CLBDB	0.	CLPB	-1.200000E-01	CLRB	1.040000E-01	CLDWB	6.000000E-02
CLDRB	1.490000E-02	CNBB	9.090000E-02	CNBDB	-7.470000E-02	CNPB	-1.790000E-02	CNRB	-1.071000E-01
CNDWB	3.000000E-03	CNDRB	-7.490000E-02	CYBB	-8.380000E-01	CYBDB	0.	CYPB	2.700000E-01
CYRB	7.270000E-02	CYDWB	-2.520000E-02	CYDRB	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.250000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINAB	1.131949E-01	COSAB	9.935728E-01	IXXPB	2.561687E 06	IZZPB	4.738313E 06	IXZPB	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPITB	1.169323E 00	KROLB	6.687655E 00	KYAWB	3.615565E 00	KDLSB	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DTBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDTS	-7.658657E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DEBDA	-6.841587E-01	DEBAD	-1.599184E-01	DEBQ	-2.161574E-01	DEBDV	-4.384185E-02	DEBDES	4.826592E-01
DEBDTS	-0.	DEBDTB	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.623302E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01	CLDWPB	5.994490E-02				
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	9.112884E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02	CNDRPB	-7.540621E-02				
DCYB	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDWB	4.397906E-04	DCYDRB	-3.682373E-03				

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LONG. CONFIG. # 101A & 105A

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.011000E 02	LADIAX	1.209000E 03	PAGE	2.040000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DA8DES	-2.960689E-01	DA8DE8	6.435643E-01	DA8DTS	-7.658660E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.826592E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW88	1.390618E 00	DW88D	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR88	2.921084E-01	DR88D	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.533961E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376028E-02

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LONG. CONFIG. # 105*

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.05[illegible]000E 02	LADIAX	1.209000E 03	PAGE	1.080000E 00		
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06		
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03		
B8	1.308000E 02	C8	2.010000E 01								
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.		
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.		
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.		
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01				
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02		
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01		
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01		
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01						
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07		
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03		
BS	2.150000E 02	CS	2.875000E 01								
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02		
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01		
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.		
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-2.387000E 00				
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02		
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01		
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02		
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01						
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04		
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05		
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01				
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01				
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01				
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.				
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06		
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01						
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01		
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.				
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01		
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03		
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02						
DCY8	4.648835E-03	DCY8D	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04		
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03						

AC 4872C

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LONG. CONFIG. # 105 *

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.05[illegible]000E 02	LADIAX	1.209000E 03	PAGE	2.080000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDAB	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	1.756879E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371618E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376025E-02

AD 4572G

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LONG. CONFIG. # 151

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.510000E 02	LADIAX	1.209000E 03	PAGE	1.050000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
~~CLDES~~	~~-4.090000E-01~~	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	~~DABDES~~	~~2.960689E-01~~	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG # 151

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.510000E 02	LADIAX	1.209000E 03	PAGE	2.050000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	~~DABDES~~	~~2.960689E-01~~	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						
P64A44	1.679143E-01								
P65A43	1.134826E 00								
P66A43	7.183666E-01								
P67A43	2.301697E-01								
P68A44	0.								
P69A43	6.946154E-02								
P70A44	1.756879E 00								
P72A46	1.869572E-01								
P73A46	1.500000E 00								
P74A46	8.231735E-01								
P76A46	-0.								
P79A47	5.731720E-01								
P80A48	0.								
P81A47	1.607372E-01								
P82A48	7.658660E-02								
~~P83A48~~	~~2.960689E 00~~								
P85A48	3.244436E 00								
P88A47	5.822206E 00								
P106A2	6.094950E-03								
P107A2	4.371610E-01								
P108A2	3.104758E-01								
P111A1	5.562472E-01								
P112A1	1.524660E 00								
P114A2	5.042006E-02								
P115A1	5.430222E-02								
P118A3	1.151619E 00								
P119A4	1.219217E 01								
P120A3	1.610243E 00								
P121A4	5.842168E-01								
P122A4	4.633850E 00								
P123A3	9.112884E-02								
P124A3	6.376025E-02								

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LONG. CONFIG. # 151B & 151D

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.512000E 02	LADIAX	1.209000E 03	PAGE	1.002000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	-4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.300000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCY8D	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG. # 151B & 151D

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.512000E 02	LADIAX	1.209000E 03	PAGE	2.002000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDAB	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.865572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.590271E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A48	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376025E-02

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LONG. CONFIG.# 151C

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.513000E 02	LADIAX	1.209000E 03	PAGE	1.003C00E 00
MGB	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E C6
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDAB	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDAB	-8.080000E-01	CMA8	-1.100000E 00	CMADB	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDAB	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	0.	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.300000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.7300C0E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935729E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747152E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-0.	DABDE8	6.435643E-01	DABDTS	-7.658657E-C6
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.559184E-C1	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-C1
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-C3
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCYB	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.7360C4E-04
DCYDRS	2.515168E-03	DCYDW8	4.3579C6E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG.# 151C

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.513000E 02	LADIAX	1.209000E 03	PAGE	2.003000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.865572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DABDES	-0.	DA8DE8	6.435643E-01	DA8DTS	-7.658660E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW88	1.390618E 00	DW88D	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR88	2.921084E-01	DR88D	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						

P64A44	1.679143E-01
P65A43	1.134826E 00
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.590271E 00
P72A46	1.865572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.656660E-02
P83A49	-0.
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376025E-02

THE BOEING COMPANY

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LONG. CONFIG. # 158

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.580000E 02	LADIAX	1.209000E 03	PAGE	1.160000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-4.000000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-4.800000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KRCL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KRCLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KRCLI	6.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-2.701444E-01	DE8AD	-1.599184E-01	CE8Q	3.014678E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG. # 158

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.580000E 02	LADIAX	1.209000E 03	PAGE	2.160000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDTB	-5.000000E-03	KDAB	1.000000E 01	KDEB	5.250000E 00	KDWB	2.000000E 00	KDRB	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DTBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDTS	-7.658660E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
~~DEBDA~~	~~-2.701444E-01~~	DEBAD	-1.599184E-01	~~DEBQ~~	~~3.014678E-01~~	DEBDV	-4.384185E-02	DEBDES	3.346437E-01
~~DEBDTS~~	~~-0.~~	DEBDTB	0.	~~DEBDAB~~	~~-1.323077E-01~~	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.623302E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01						
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	9.112884E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02						

P64A44	1.679143E-01
P65A44	1.582706E 00
~~P66A43~~	~~2.836516E-01~~
~~P67A43~~	~~2.301697E-01~~
P68A44	0.
P69A43	6.946154E-02
P70A44	1.756879E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376026E-02

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LONG. CONFIG. # 158A

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.582000E 02	LADIAX	1.209000E 03	PAGE	1.004000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-4.000000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.300000E 00	CMDFS	0.	CMQS	-4.800000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	5.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-2.701444E-01	DE8AD	-1.599184E-01	DE8Q	3.014678E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCY8D	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.357906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG. # 158A

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.502000E 02	LADIAX	1.209000E 03	PAGE	2.004000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000F 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDTB	-5.000000E-03	KDAB	1.000000E 01	KDEB	5.250000E 00	KDWB	2.000000E 00	KDRB	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DTBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDTS	-7.658660E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.922206E-01				
DEBDA	-2.701444E-01	DEBAD	-1.599184E-01	DEBQ	3.014678E-01	DEBDV	-4.384195E-02	DEBDES	4.933849E-01
DEBDTS	-0.	DEBDTB	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.623302E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01						
DRBB	2.921094E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	9.112884E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02						

P64A44	1.679143E-01
P65A44	1.582706E 00
P66A43	2.836516E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	2.590271E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.094950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112894E-02
P124A3	6.376025E-02

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LONG. CONFIG. # 159

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.590000E 02	LADIAX	1.209000E 03	PAGE	1.070000E 00
MGB	1.500000E 05	ATRB	6.500000E 00	THTRB	1.819400E 04	IXXB	2.570000E 06	IYYB	2.250000E 06
IZZB	4.730000E 06	IXZB	1.600000E 05	QTRB	4.640000E 01	VTRB	1.975000E 02	SB	2.821000E 03
BB	1.308000E 02	CB	2.010000E 01						
CDTRB	1.390000E-01	CDAB	5.440000E-01	CDDTB	0.	CDDVB	0.	CDDEB	0.
CDDAB	0.	CLTRB	1.124200E 00	CLAB	5.418000E 00	CLDTB	0.	CLDVB	0.
CLDEB	5.200000E-01	CLDAB	-8.080000E-01	CMAB	-1.100000E 00	CMADB	-2.720000E-01	CMDTB	0.
CMDVB	-7.460000E-04	CMDEB	-9.750000E-01	CMDAB	-1.290000E-01	CMQB	-7.100000E-01		
CLBB	-1.743000E-01	CLBDB	0.	CLPB	-1.200000E-01	CLRB	1.040000E-01	CLDWB	6.000000E-02
CLDRB	1.490000E-02	CNBB	9.090000E-02	CNBDB	-7.470000E-02	CNPB	-1.790000E-02	CNRB	-1.071000E-01
CNDWB	3.000000E-03	CNDRB	-7.490000E-02	CYBB	-8.380000E-01	CYBDB	0.	CYPB	2.700000E-01
CYRB	7.270000E-02	CYDWB	-2.520000E-02	CYDRB	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-4.800000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINAB	1.131949E-01	COSAB	9.935728E-01	IXXPB	2.561687E 06	IZZPB	4.738313E 06	IXZPB	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481058E 05
KPITB	1.169323E 00	KROLB	6.687655E 00	KYAWB	3.615565E 00	KDLSB	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DTBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDTS	-7.658657E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DEBDA	-6.841587E-01	DEBAD	-1.599184E-01	DEBQ	3.014678E-01	DEBDV	-4.384185E-02	DEBDES	3.346437E-01
DEBDTS	-0.	DEBDTB	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.623302E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01	CLDWPB	5.994490E-02				
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	9.112884E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02	CNDRPB	-7.540621E-02				
DCYB	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDWB	4.397906E-04	DCYDRB	-3.682373E-03				

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LONG. CONFIG. # 159

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.590000E 02	LADIAX	1.209000E 03	PAGE	2.070000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDTB	-5.000000E-03	KDAB	1.000000E 01	KDEB	5.250000E 00	KDWB	2.000000E 00	KDRB	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DTBDA	-1.869572E 02	DTBDV	-1.646347E 02	DTBDTS	3.000000E-01	DTBDAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDEB	6.435643E-01	DABDTS	-7.658660E-06
DABDTB	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DEBDA	-6.841587E-01	DEBAD	-1.599184E-01	~~DEBQ~~	~~3.014678E-01~~	DEBDV	-4.384185E-02	DEBDES	3.346437E-01
DEBDTS	-0.	DEBDTB	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DWBB	1.390618E 00	DWBBD	-3.047475E-02	DWBP	7.761894E-02	DWBR	-2.185805E-01	DWBDWS	7.623302E-01
DWBDRS	2.521003E-02	DWBDRB	-2.715111E-01						
DRBB	2.921084E-01	DRBBD	-1.151619E 00	DRBP	-6.096087E-01	DRBR	-1.610243E-01	DRBDWS	9.112884E-03
DRBDRS	5.366150E-01	DRBDWB	1.275205E-02						

P64A44	1.679143E-01
~~P65A44~~	~~1.582706E 00~~
P66A43	7.183666E-01
P67A43	2.301697E-01
P68A44	0.
P69A43	6.946154E-02
P70A44	1.756879E 00
P72A46	1.869572E-01
P73A46	1.500000E 00
P74A46	8.231735E-01
P76A46	-0.
P79A47	5.731720E-01
P80A48	0.
P81A47	1.607372E-01
P82A48	7.658660E-02
P83A47	2.960689E 00
P85A48	3.244436E 00
P88A47	5.822206E 00
P106A2	6.054950E-03
P107A2	4.371610E-01
P108A2	3.104758E-01
P111A1	5.562472E-01
P112A1	1.524660E 00
P114A2	5.042006E-02
P115A1	5.430222E-02
P118A3	1.151619E 00
P119A4	1.219217E 01
P120A3	1.610243E 00
P121A4	5.842168E-01
P122A4	4.633850E 00
P123A3	9.112884E-02
P124A3	6.376025E-02

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LONG. CONFIG. # 159A & 159B

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.591000E 02	LADIAX	1.209000E 03	PAGE	1.005000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDF8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.080000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-2.070000E 00	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.300000E 00	CMDFS	0.	CMQS	-4.800000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140851E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	3.014678E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCYB	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.357906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG. # 159A & 159B

DATE	1.210650E 01	AMFSLT	1.200000E 00	LONGAX	1.591000E 02	LADIAX	1.209000E 03	PAGE	2.005000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDAB	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.865572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658660E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
DE8DA	-6.841587E-01	DE8AD	-1.599184E-01	DE8Q	3.014678E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						
P64A44	1.679143E-01								
P65A44	1.582706E 00								
P66A43	7.183666E-01								
P67A43	2.301697E-01								
P68A44	0.								
P69A43	6.946154E-02								
P70A44	2.590271E 00								
P72A46	1.865572E-01								
P73A46	1.500000E 00								
P74A46	8.231735E-01								
P76A46	-0.								
P79A47	5.731720E-01								
P80A48	0.								
P81A47	1.607372E-01								
P82A48	7.658660E-02								
P83A47	2.960689E 00								
P85A48	3.244436E 00								
P88A47	5.822206E 00								
P106A2	6.094950E-03								
P107A2	4.371610E-01								
P108A2	3.104758E-01								
P111A1	5.562472E-01								
P112A1	1.524660E 00								
P114A2	5.042006E-02								
P115A1	5.430222E-02								
P118A3	1.151619E 00								
P119A4	1.219217E 01								
P120A3	1.610243E 00								
P121A4	5.842168E-01								
P122A4	4.633850E 00								
P123A3	9.112884E-02								
P124A3	6.376025E-02								

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DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.610000E 02	LADIAX	1.209000E 03	PAGE	1.180000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.3C8000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDAB	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDAB	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDAB	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	~~CMAS~~	~~-5.000000E-01~~	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-1.560000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696951E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DABDA	1.622218E 00	DABDV	0.	DABDES	-2.960689E-01	DABDE8	6.435643E-01	DABDTS	-7.658657E-06
DABDT8	8.036862E-05	DABAD	2.865860E-01	DABQ	-5.822206E-01				
~~DEBDA~~	~~-1.020948E 00~~	DEBAD	-1.599184E-01	DEBQ	-2.161574E-01	DEBDV	-4.384185E-02	DEBDES	3.346437E-01
DEBDTS	-0.	DEBDTA	0.	DEBDAB	-1.323077E-01	DEBDFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCYBD	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736004E-04
DCYDRS	2.515168E-03	DCYDW8	4.397906E-04	DCYDR8	-3.682373E-03				

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LONG. CONFIG. # 161

DATE	1.109650E 01	AMESLT	1.200000E 00	LONGAX	1.610000E 02	LADIAX	1.209000E 03	PAGE	2.180000E 00
KDA	5.000000E 00	KAD	-5.000000E 00	KB	-5.000000E 00	KBD	-1.000000E 01	KDV	1.000000E 00
KP	5.000000E-01	KQ	1.000000E 00	KR	-1.000000E 00				
KDT8	-5.000000E-03	KDA8	1.000000E 01	KDE8	5.250000E 00	KDW8	2.000000E 00	KDR8	1.000000E 01
KDTS	-10.000000E-04	KDFS	1.000000E 00	KDES	1.000000E 00	KDWS	-1.000000E 00	KDRS	1.000000E 00
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DA8	0.		
DA8DA	1.622218E 00	DA8DV	0.	DA8DES	-2.960689E-01	DA8DE8	6.435643E-01	DA8DTS	-7.658660E-06
DA8DT8	8.036862E-05	DA8AD	2.865860E-01	DA8Q	-5.822206E-01				
~~DE8DA~~	~~-1.020948E 00~~	DE8AD	-1.599184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	3.346437E-01
DE8DTS	-0.	DE8DT8	0.	DE8DA8	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01						
DR8B	2.921084E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02						
P64A44	1.679143E-01								
P65A43	1.134826E 00								
~~P66A43~~	~~1.071995E 00~~								
P67A43	2.301697E-01								
P68A44	0.								
P69A43	6.946154E-02								
P70A44	1.756879E 00								
P72A46	1.869572E-01								
P73A46	1.500000E 00								
P74A46	8.231735E-01								
P76A46	-0.								
P79A47	5.731720E-01								
P80A48	0.								
P81A47	1.607372E-01								
P82A48	7.658660E-02								
P83A47	2.960689E 00								
P85A48	3.244436E 00								
P88A47	5.822206E 00								
P106A2	6.094950E-03								
P107A2	4.371610E-01								
P108A2	3.104758E-01								
P111A1	5.562472E-01								
P112A1	1.524660E 00								
P114A2	5.042006E-02								
P115A1	5.430222E-02								
P118A3	1.151619E 00								
P119A4	1.219217E 01								
P120A3	1.610243E 00								
P121A4	5.842168E-01								
P122A4	4.633850E 00								
P123A3	9.112884E-02								
P124A3	6.376025E-02								

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LONG. CONFIG. # 161B

DATE	1.210650E 01	AMESLT	1.200000E 00	LONGAX	1.612000E 02	LADIAX	1.209000E 03	PAGE	1.000000E 00
MG8	1.500000E 05	ATR8	6.500000E 00	THTR8	1.819400E 04	IXX8	2.570000E 06	IYY8	2.250000E 06
IZZ8	4.730000E 06	IXZ8	1.600000E 05	QTR8	4.640000E 01	VTR8	1.975000E 02	S8	2.821000E 03
B8	1.308000E 02	C8	2.010000E 01						
CDTR8	1.390000E-01	CDA8	5.440000E-01	CDDT8	0.	CDDV8	0.	CDDE8	0.
CDDA8	0.	CLTR8	1.124200E 00	CLA8	5.418000E 00	CLDT8	0.	CLDV8	0.
CLDE8	5.200000E-01	CLDA8	-8.080000E-01	CMA8	-1.100000E 00	CMAD8	-2.720000E-01	CMDT8	0.
CMDV8	-7.460000E-04	CMDE8	-9.750000E-01	CMDA8	-1.290000E-01	CMQ8	-7.100000E-01		
CLB8	-1.743000E-01	CLBD8	0.	CLP8	-1.200000E-01	CLR8	1.040000E-01	CLDW8	6.000000E-02
CLDR8	1.490000E-02	CNB8	9.090000E-02	CNBD8	-7.470000E-02	CNP8	-1.790000E-02	CNR8	-1.071000E-01
CNDW8	3.000000E-03	CNDR8	-7.490000E-02	CYB8	-8.380000E-01	CYBD8	0.	CYP8	2.700000E-01
CYR8	7.270000E-02	CYDW8	-2.520000E-02	CYDR8	2.110000E-01				
MGS	5.000000E 05	ATRS	2.700000E 00	THTRS	1.147870E 05	IXXS	1.750000E 07	IYYS	3.000000E 07
IZZS	4.500000E 07	IXZS	9.500000E 05	QTRS	4.640000E 01	VTRS	1.975000E 02	SS	5.500000E 03
BS	2.150000E 02	CS	2.875000E 01						
CDTRS	4.500000E-01	CDAS	1.070000E 00	CDDTS	0.	CDDVS	0.	CDDES	-6.200000E-02
CDDFS	0.	CLTRS	1.940000E 00	CLAS	6.810000E 00	CLADS	-3.959000E-01	CLQS	8.043000E-01
CLDES	4.090000E-01	CLDFS	0.	CMAS	-5.000000E-01	CMADS	-5.550000E-01	CMDTS	0.
CMDVS	0.	CMDES	-2.300000E 00	CMDFS	0.	CMQS	-2.387000E 00		
CLBS	-1.955000E-01	CLBDS	-6.900000E-04	CLPS	-2.442000E-01	CLRS	1.955000E-01	CLDWS	9.730000E-02
CLDRS	2.290000E-03	CNBS	2.180000E-01	CNBDS	3.600000E-02	CNPS	9.050000E-02	CNRS	-2.883000E-01
CNDWS	-10.000000E-05	CNDRS	-1.200000E-01	CYBS	-9.773000E-01	CYBDS	-7.400000E-02	CYPS	6.000000E-02
CYRS	1.105000E-01	CYDWS	-3.660000E-02	CYDRS	2.464000E-01				
SINA8	1.131949E-01	COSA8	9.935728E-01	IXXP8	2.561687E 06	IZZP8	4.738313E 06	IXZP8	-8.702974E 04
SINAS	4.710298E-02	COSAS	9.988900E-01	IXXPS	1.747162E 07	IZZPS	4.502838E 07	IXZPS	-3.481098E 05
KPIT8	1.169323E 00	KROL8	6.687655E 00	KYAW8	3.615565E 00	KDLS8	2.809866E 01		
KPITS	2.445667E-01	KROLS	3.140891E 00	KYAWS	1.218708E 00	KDLSS	1.643488E 01		
KPITCH	2.091523E-01	KROLL	4.696551E-01	KYAW	3.370727E-01	KDLS	5.848990E-01		
DT8DA	-1.869572E 02	DT8DV	-1.646347E 02	DT8DTS	3.000000E-01	DT8DAB	0.		
DAB8DA	1.622218E 00	DAB8DV	0.	DAB8DES	-2.960689E-01	DAB8DE8	6.435643E-01	DAB8DTS	-7.658657E-06
DAB8DT8	8.036862E-05	DAB8AD	2.865860E-01	DAB8Q	-5.822206E-01				
DE8DA	-1.020948E 00	DE8AD	-1.559184E-01	DE8Q	-2.161574E-01	DE8DV	-4.384185E-02	DE8DES	4.933849E-01
DE8DTS	-0.	DE8DT8	0.	DE8DAB	-1.323077E-01	DE8DFS	-0.		
DW8B	1.390618E 00	DW8BD	-3.047475E-02	DW8P	7.761894E-02	DW8R	-2.185805E-01	DW8DWS	7.623302E-01
DW8DRS	2.521003E-02	DW8DR8	-2.715111E-01	CLDWP8	5.994490E-02				
DR8B	2.921094E-01	DR8BD	-1.151619E 00	DR8P	-6.096087E-01	DR8R	-1.610243E-01	DR8DWS	9.112884E-03
DR8DRS	5.366150E-01	DR8DW8	1.275205E-02	CNDRP8	-7.540621E-02				
DCY8	4.648835E-03	DCY8D	-7.553669E-04	DCYP	-4.099582E-03	DCYR	-1.408144E-04	DCYDWS	-3.736046E-04
DCYDRS	2.515168E-03	DCYDW8	4.357906E-04	DCYDR8	-3.682373E-03				

139

LONG. CONFIG.# 161B

```
   DATE   1.210650E 01 AMESLT   1.200000E 00 LONGAX   1.612000E 02 LADIAX   1.209000E 03   PAGE   2.006000E 00

    KDA   5.000000E 00    KAD  -5.000000E 00     KB  -5.000000E 00    KBD  -1.000000E 01    KDV   1.000000E 00
     KP   5.000000E-01     KQ   1.000000E 00     KR  -1.000000E 00
   KDT8  -5.000000E-03   KDAB   1.000000E 01   KDE8   5.250000E 00   KDW8   2.000000E 00   KDR8   1.000000E 01
   KDTS -10.000000E-04   KDFS   1.000000E 00   KDES   1.000000E 00   KDWS  -1.000000E 00   KDRS   1.000000E 00

  DT8DA  -1.865572E 02  DT8DV  -1.646347E 02 DT8DTS   3.000000E-01 DT8DAB   0.

  DABDA   1.622218E 00  DABDV   0.           DABDES  -2.960689E-01 DABDE8   6.435643E-01 DABDTS  -7.658660E-06
 DABDT8   8.036862E-05  DABAD   2.865860E-01   DABQ  -5.822206E-01

  DE8DA  -1.020948E 00  DE8AD  -1.599184E-01   DE8Q  -2.161574E-01  DE8DV  -4.384185E-02 DE8DES   4.933849E-01
 DE8DTS  -0.           DE8DT8   0.           DE8DAB  -1.323077E-01 DE8DFS  -0.

   DW8B   1.390618E 00  DW8BD  -3.047475E-02   DW8P   7.761894E-02   DW8R  -2.185805E-01 DW8DWS   7.623302E-01
 DW8DRS   2.521003E-02 DW8DR8  -2.715111E-01

   DR8B   2.921084E-01  DR8BD  -1.151619E 00   DR8P  -6.096087E-01   DR8R  -1.610243E-01 DR8DWS   9.112884E-03
 DR8DRS   5.366150E-01 DR8DW8   1.275205E-02

 P64A44   1.679143E-01
 P65A43   1.134826E 00
 P66A43   1.071995E 00
 P67A43   2.301697E-01
 P68A44   0.
 P69A43   6.946154E-02
 P70A44   2.590271E 00

 P72A46   1.869572E-01
 P73A46   1.500000E 00
 P74A46   8.231735E-01
 P76A46  -0.

 P79A47   5.731720E-01
 P80A48   0.
 P81A47   1.607372E-01
 P82A48   7.658660E-02
 P83A47   2.960689E 00
 P85A48   3.244436E 00
 P88A47   5.822206E 00

 P106A2   6.094950E-03
 P107A2   4.371610E-01
 P108A2   3.104758E-01
 P111A1   5.562472E-01
 P112A1   1.524660E 00
 P114A2   5.042006E-02
 P115A1   5.430222E-02

 P118A3   1.151619E 00
 P119A4   1.219217E 01
 P120A3   1.610243E 00
 P121A4   5.842168E-01
 P122A4   4.633850E 00
 P123A3   9.112884E-02
 P124A3   6.376025E-02
```

APPENDIX C

AIRPLANE ELECTRO-HYDRAULIC POWER

CONTROL UNITS

APPENDIX C - AIRPLANE ELECTRO-HYDRAULIC POWER CONTROL UNITS

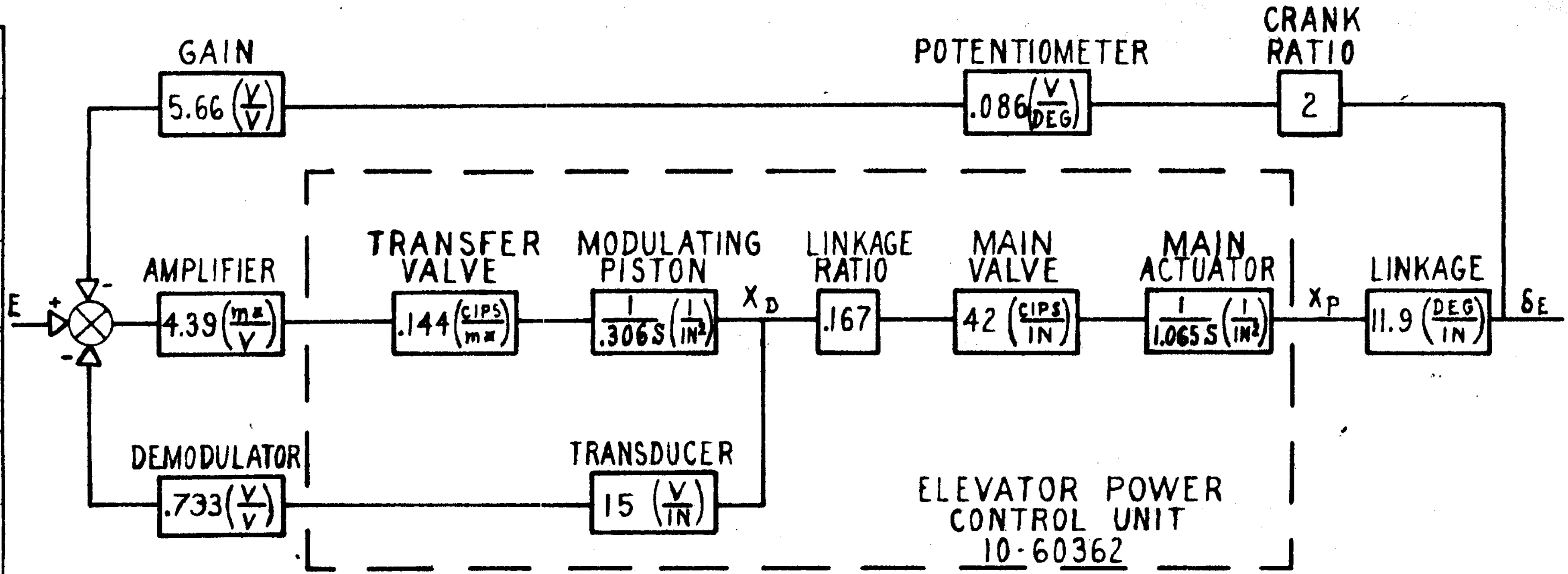
The 367-80 airplane is equipped with electro-hydraulic power control units on the following controls: Left hand elevator, right hand elevator, spoilers, rudder, aileron, lateral control system (spoiler drive PCU).

In addition, the thrust reversers are controlled by an electric servo system which drives the reverser levers which in turn control the clam shell hydraulic actuators.

During the -80 variable stability programs, the electro-hydraulic actuators are utilized to accept signals from the airborne computer and drive the -80 control surfaces to perform the dynamics of the simulated airplane. For this we have 5 degree of freedom control, the pitching equation by elevator, the roll equation by wheel (lateral control), the drag equation by thrust reverser modulation, the yawing moment equation by rudder, and the lift equation by spoilers. For each of the aforementioned systems, this appendix contains a block diagram, transient response, frequency response, the linearized transfer functions, surface rate limits, and displacement limits. Also, the hysteresis of the lateral control system is included.

In summarizing, the 367-80 is equipped with the electro-hydraulic actuators on each controlled axes except thrust reversers, the dynamics of which are very good and the frequency response entirely sufficient for use in a variable stability control system.

LIST OF ILLUSTRATIONS



NOMENCLATURE

E - INPUT VOLTAGE, VOLTS

X_D - MODULATING ACTUATOR DISPLACEMENT, INCHES

X_P - MAIN ACTUATOR DISPLACEMENT, INCHES

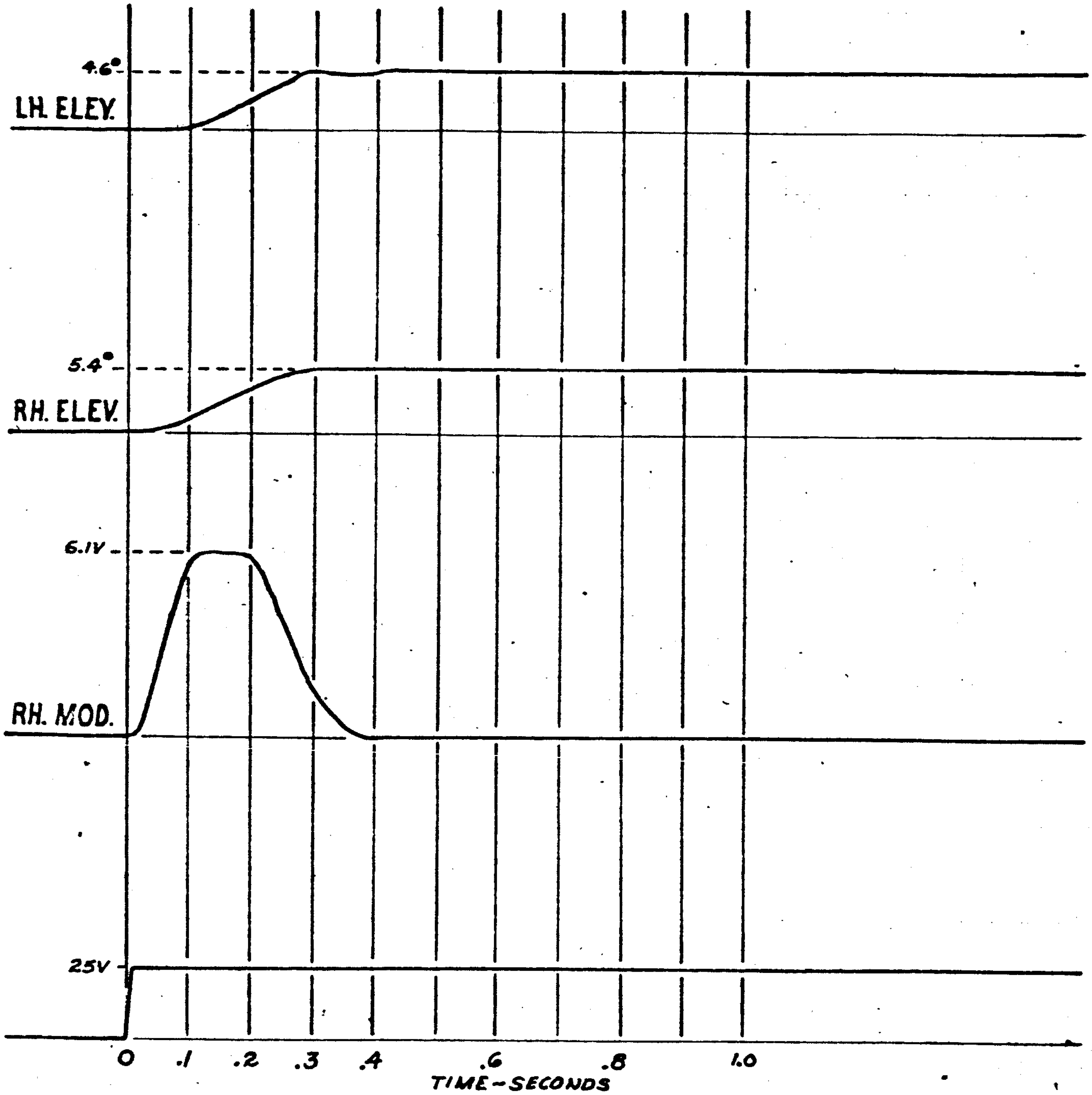
δ_E - ELEVATOR DISPLACEMENT. DEGREES

S - LAPLACE OPERATOR

MAX NO LOAD SURFACE RATE = $25^{\circ}/\text{SEC}$ (ELECT. MODE)

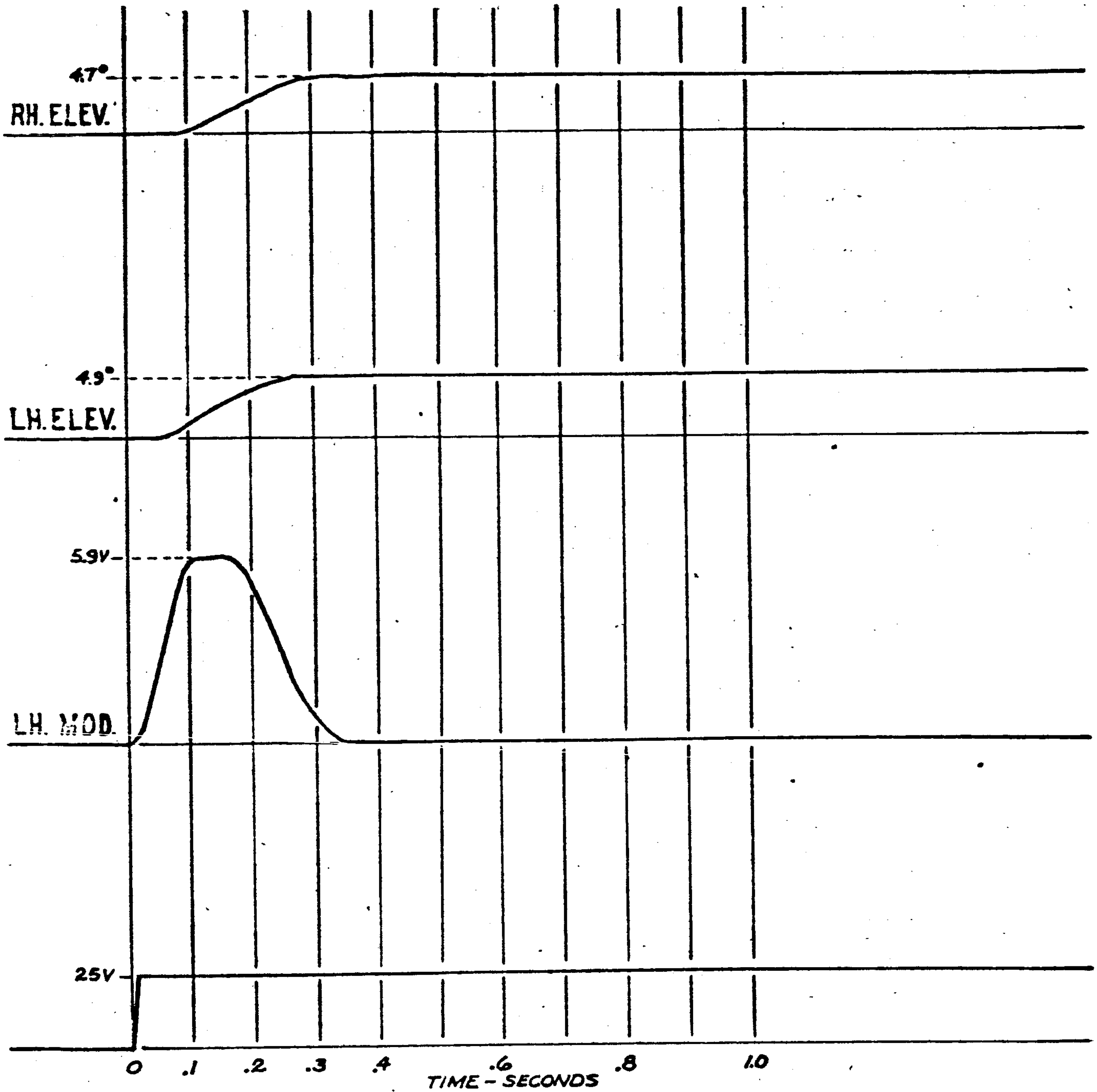
$$\delta_E/E = \frac{K}{.06S+1}$$

ENGR.			REVISED	DATE	BLOCK DIAGRAM ELEVATOR (AUTOPILOT MODE)	367-80
CHECK						FIG. 1
APR						
APR					THE BOEING COMPANY RENTON, WASHINGTON	C4



TEST NO 655-1 COND. 1. 38. 03. 05

CALC	D.E.G.	4-13-65	REVISED	DATE	RIGHT HAND MASTER ELEVATOR TRANSIENT RESPONSE (ELECTRICAL MODE)	FIG. 2
CHECK						
APR						
APR.					THE BOEING COMPANY	PAGE C5



TEST NO 655-1 COND 1.38.03.06

CALC	D. E. G.	4-13-65	REVISED	DATE	LEFTHAND MASTER	FIG. 3
CHECK					ELEVATOR TRANSIENT RESPONSE (ELECTRICAL MODE)	
APR						
APR					THE BOEING COMPANY	PAGE C6

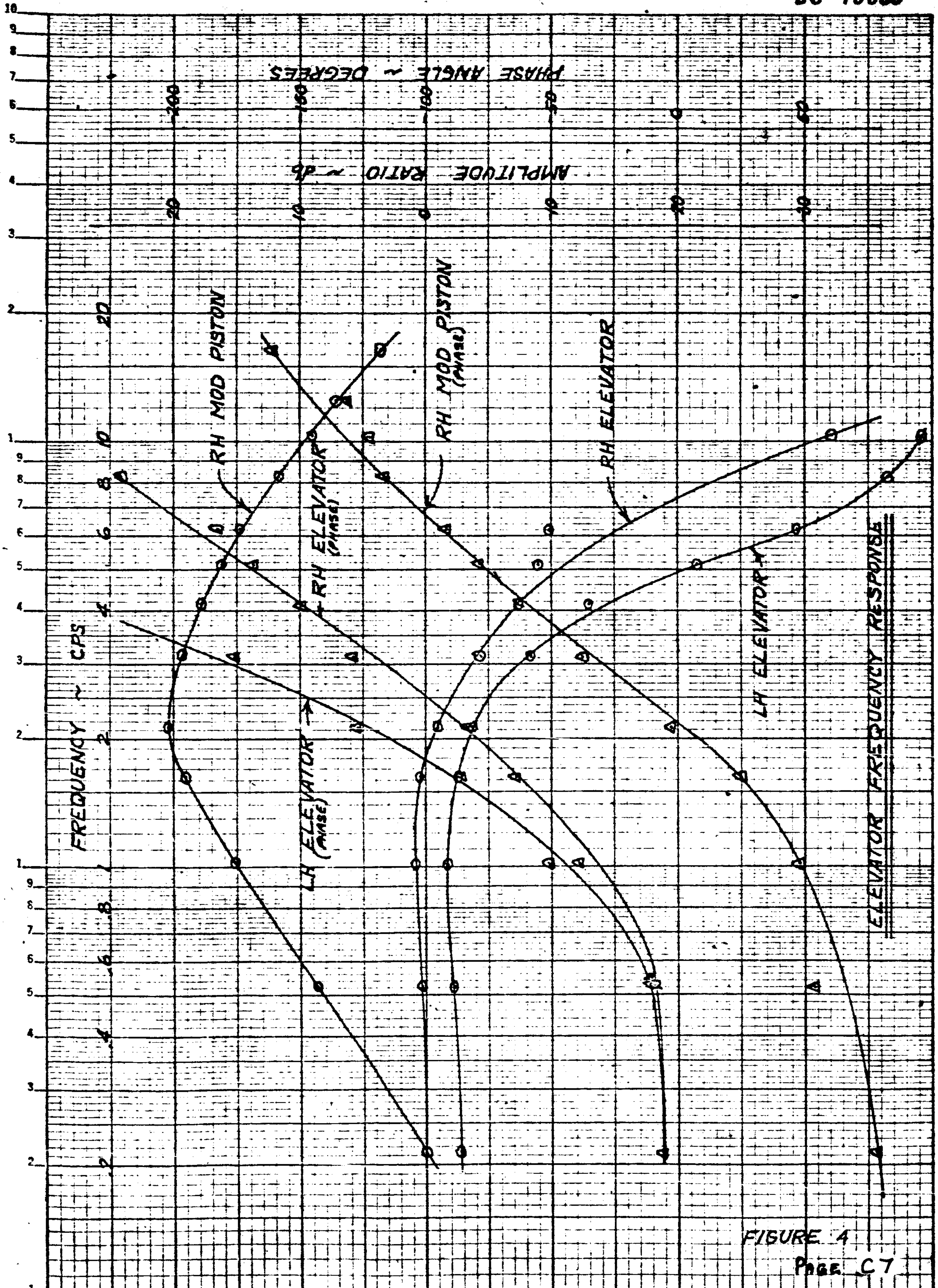
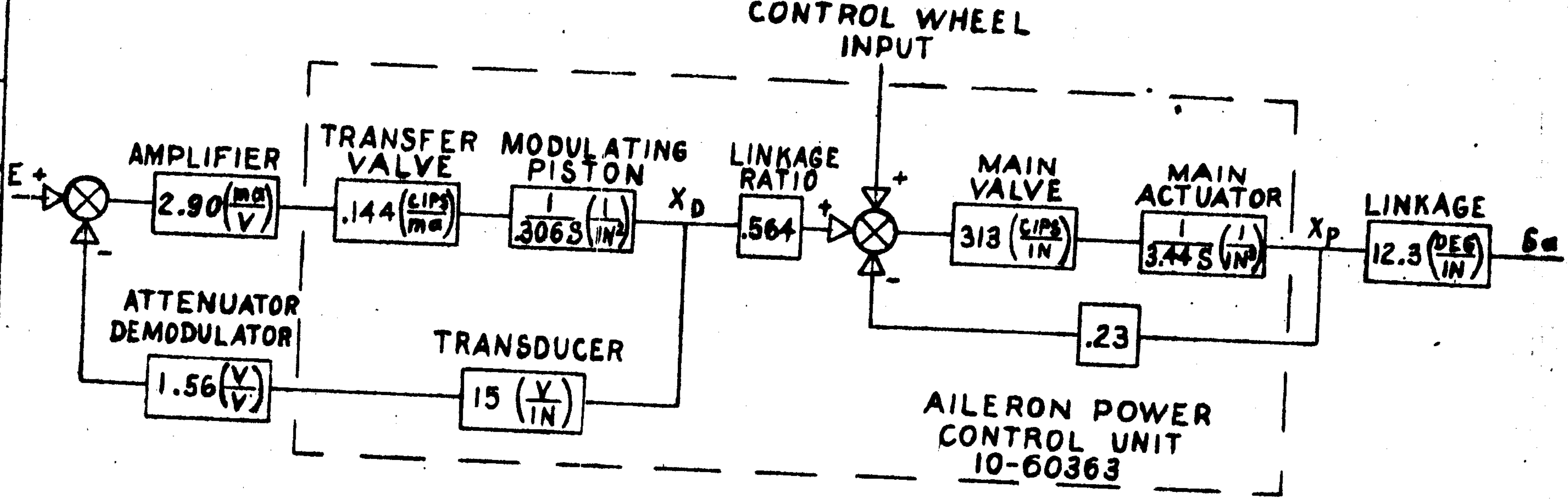


FIGURE 4

SEMI-LOGARITHMIC 359-71 KEUFFEL & ESSER CO. MADE IN U.S.A. 3 CYCLES X 70 DIVISIONS



NOMENCLATURE

E - INPUT VOLTAGE, VOLTS

X_D - MODULATING ACTUATOR DISPLACEMENT, INCHES

X_P - MAIN ACTUATOR DISPLACEMENT, INCHES

δ_a - AILERON DISPLACEMENT, DEGREES

S - LAPLACE OPERATOR

δ_a MAX NO LOAD SURFACE RATE = 68 °/sec (ELECT. MODE)

$$\delta_a/E = \frac{K}{(.014S+1)(.05S+1)}$$

CALC			REVISED	DATE
CHECK				
APR				
APR				

BLOCK DIAGRAM
AILERON (AUTOPILOT MODE)

THE BOEING COMPANY
RENTON, WASHINGTON

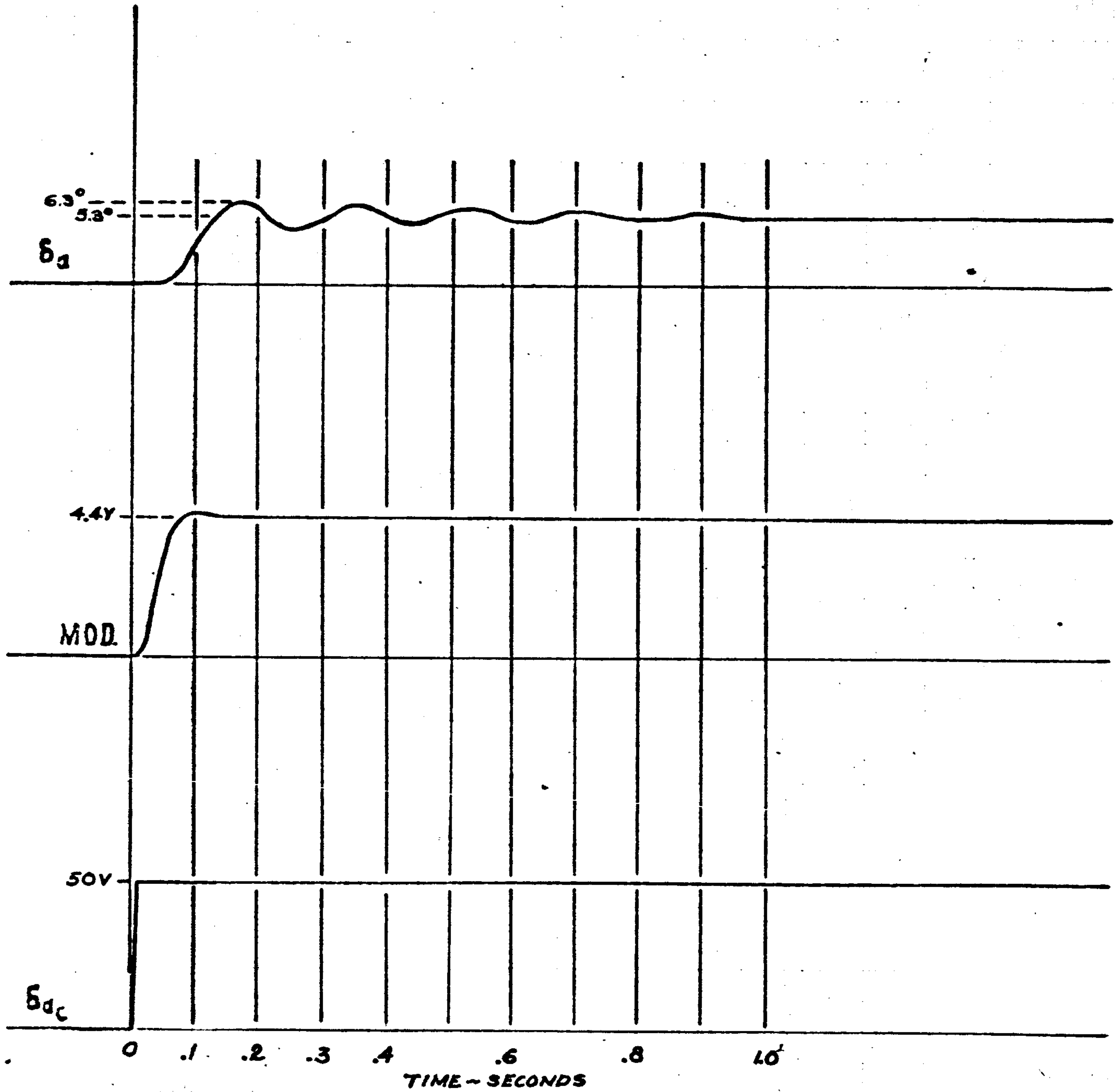
367-80

FIG. 5

TD 1017-R8

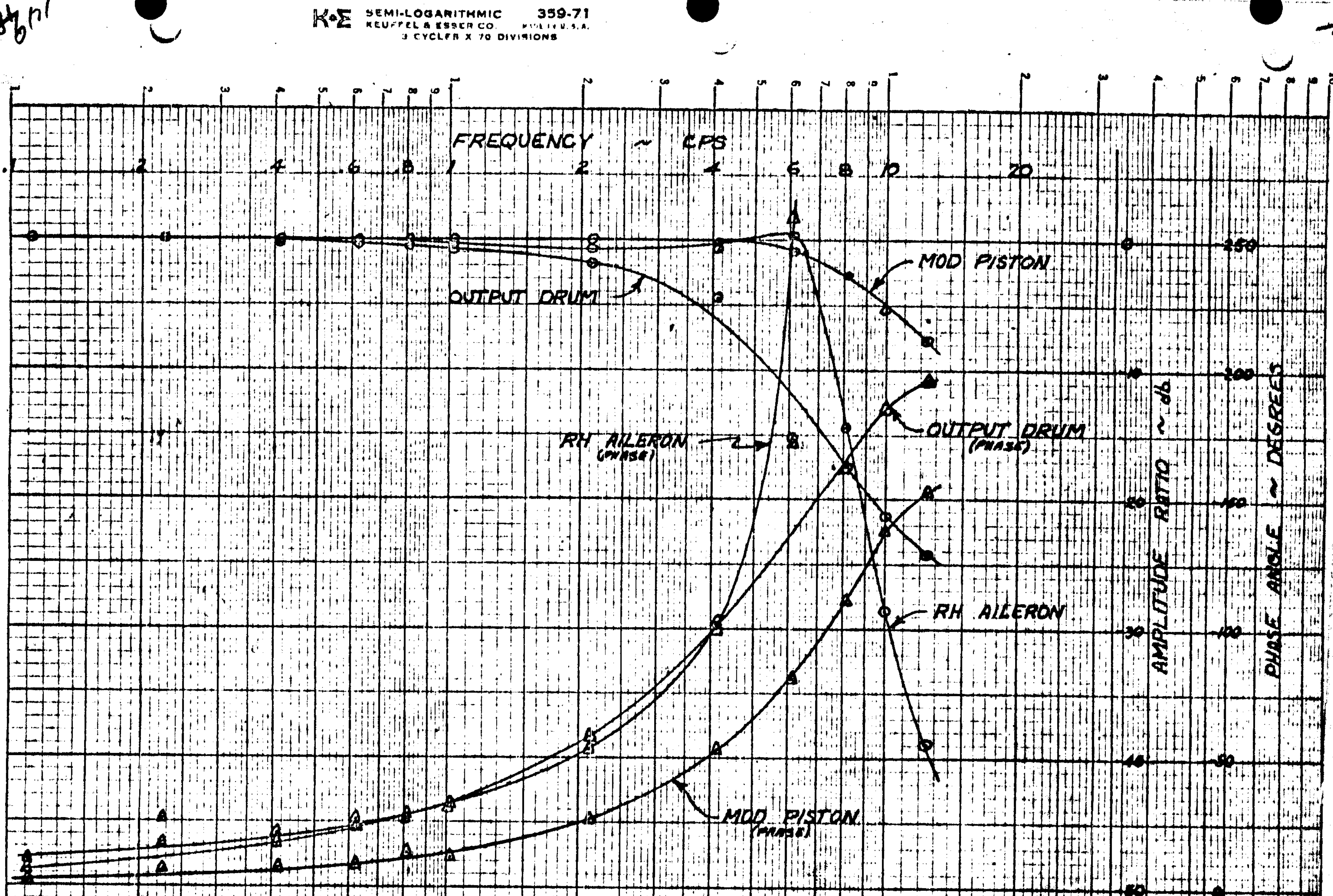
6-7000

147



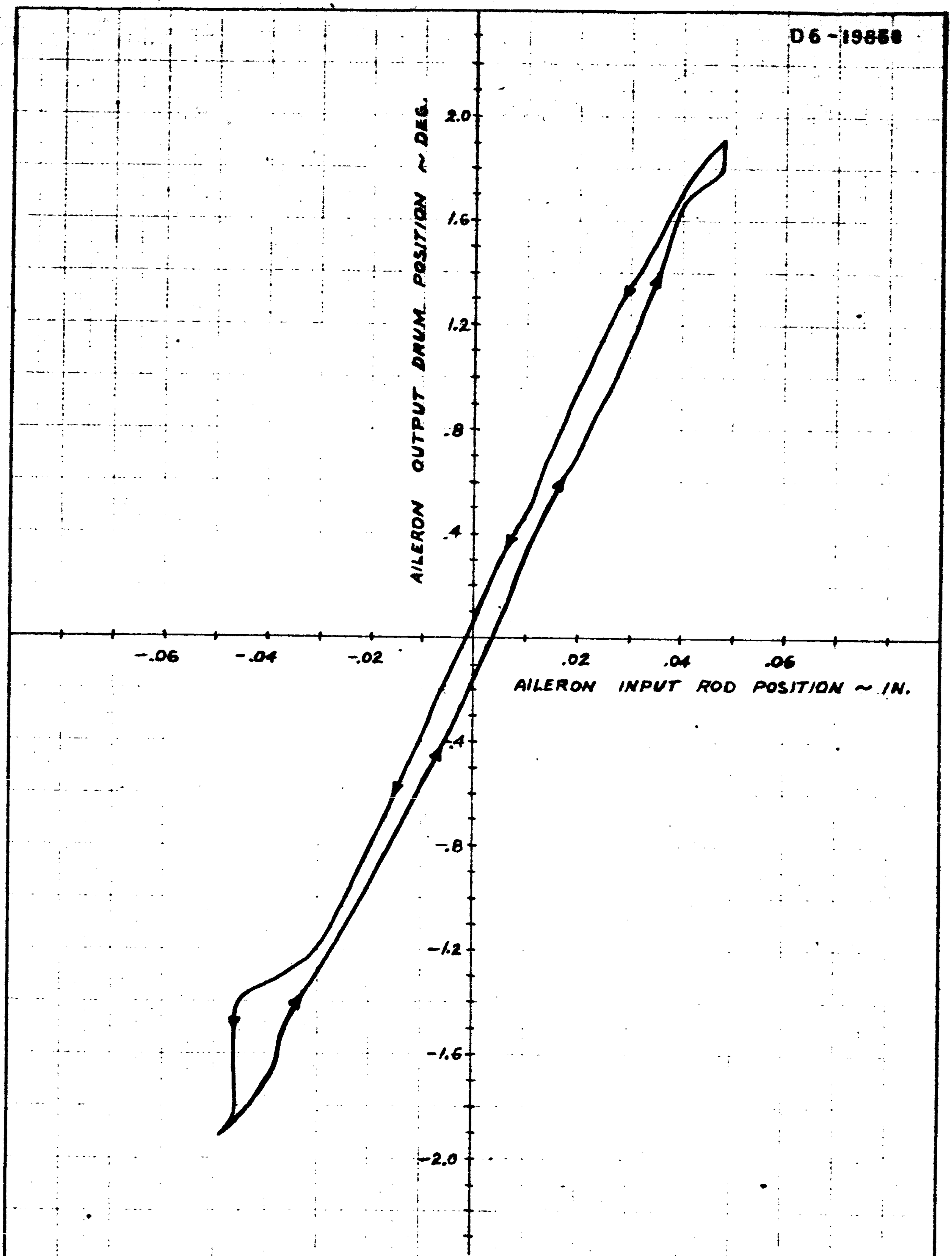
TEST NO 655-1 COND. 1.38.03.04

CALC	D.E.G.	4-13-65	REVISED	DATE	AILERON TRANSIENT RESPONSE (ELECTRICAL MODE)	FIG. 6
CHECK						
APR						
APR					THE BOEING COMPANY	PAGE C9



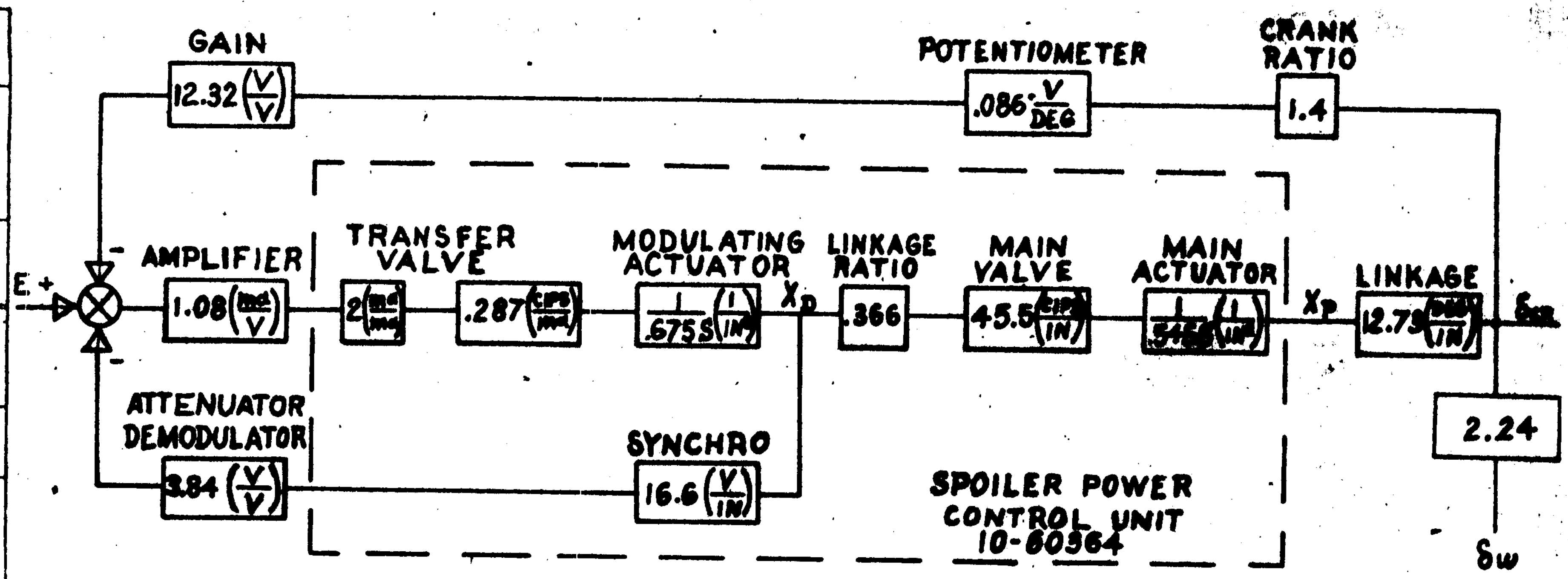
AILERON FREQUENCY RESPONSE

FIGURE 7



			REVISED	DATE		
CALC					AILERON PCU HYSTERESIS	367-80
CHECK						
APR						FIG. 8
APR						
					THE BOEING COMPANY	PAGE C11

TD 461 C-R4



NOMENCLATURE

E - INPUT VOLTAGE, VOLTS

X_D - MODULATING ACTUATOR DISPLACEMENT, INCHES

X_P - MAIN ACTUATOR DISPLACEMENT, INCHES

δ_{CR} - SPOILER ACTUATOR CRANK DISPLACEMENT, DEGREES

S - LAPLACE OPERATOR

δ_W - SAFETY PILOTS WHEEL POSITION, DEGREES

MAX δ_W RATE = 180 °/sec (ELECT. MODE)

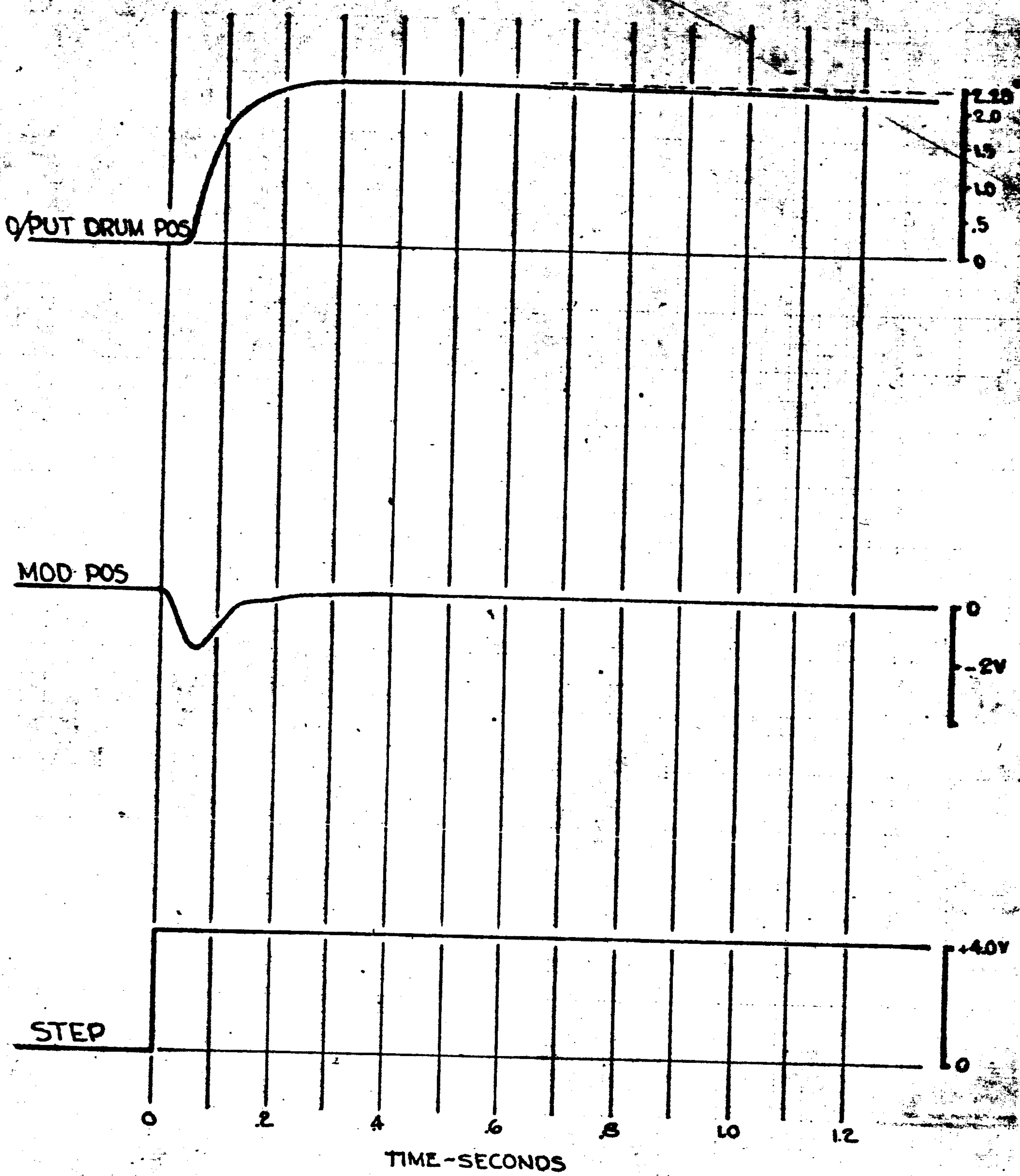
δ_W MAX = ± 63° (ELECT. MODE)

CALC			REVISED	DATE
CHECK				
APR				
APR				

BLOCK DIAGRAM
SPOILER DRIVE P.C.U.

THE BOEING COMPANY
RENTON, WASHINGTON

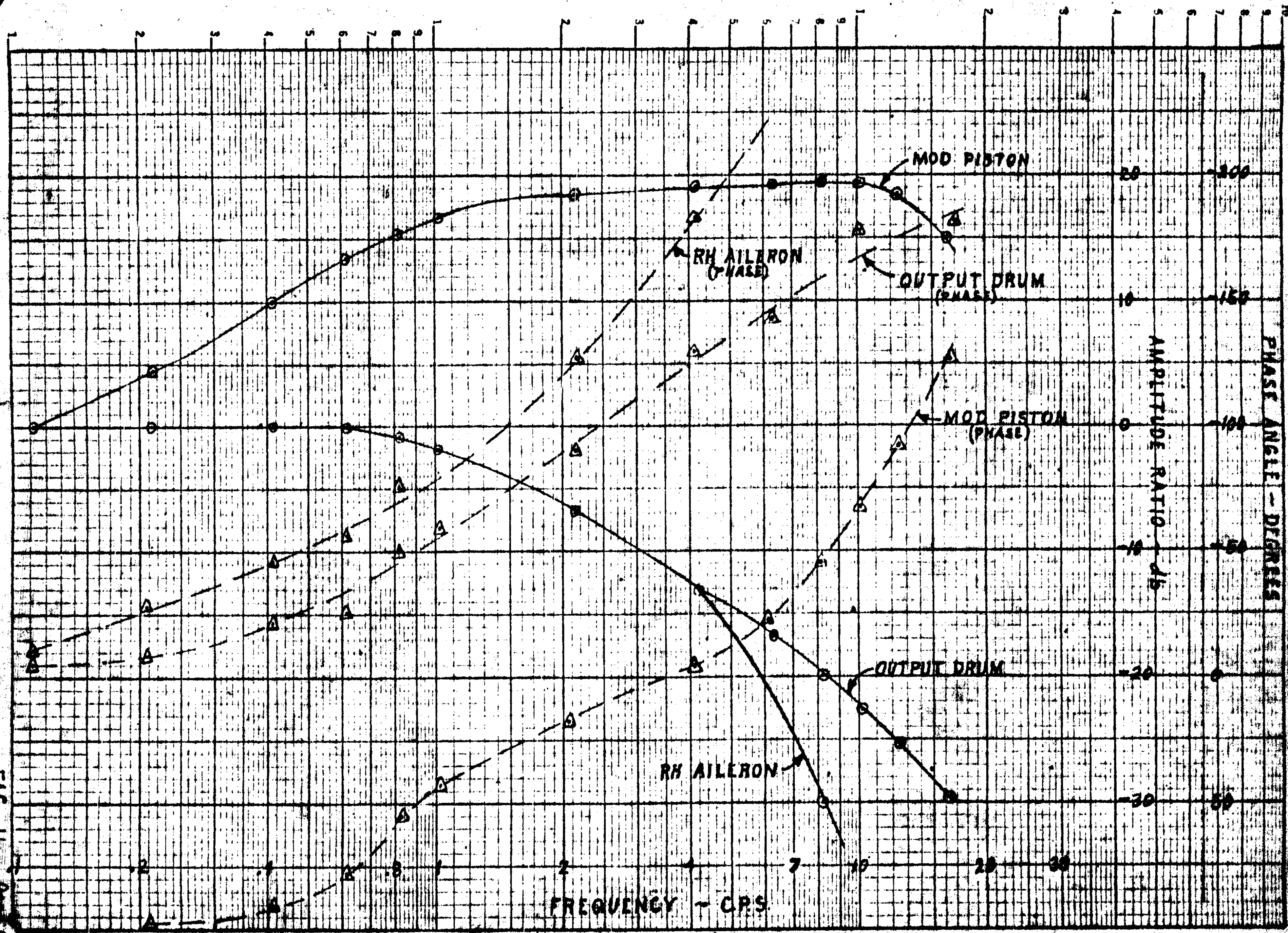
367-80
FIG. 9



ELECTRICAL MODE

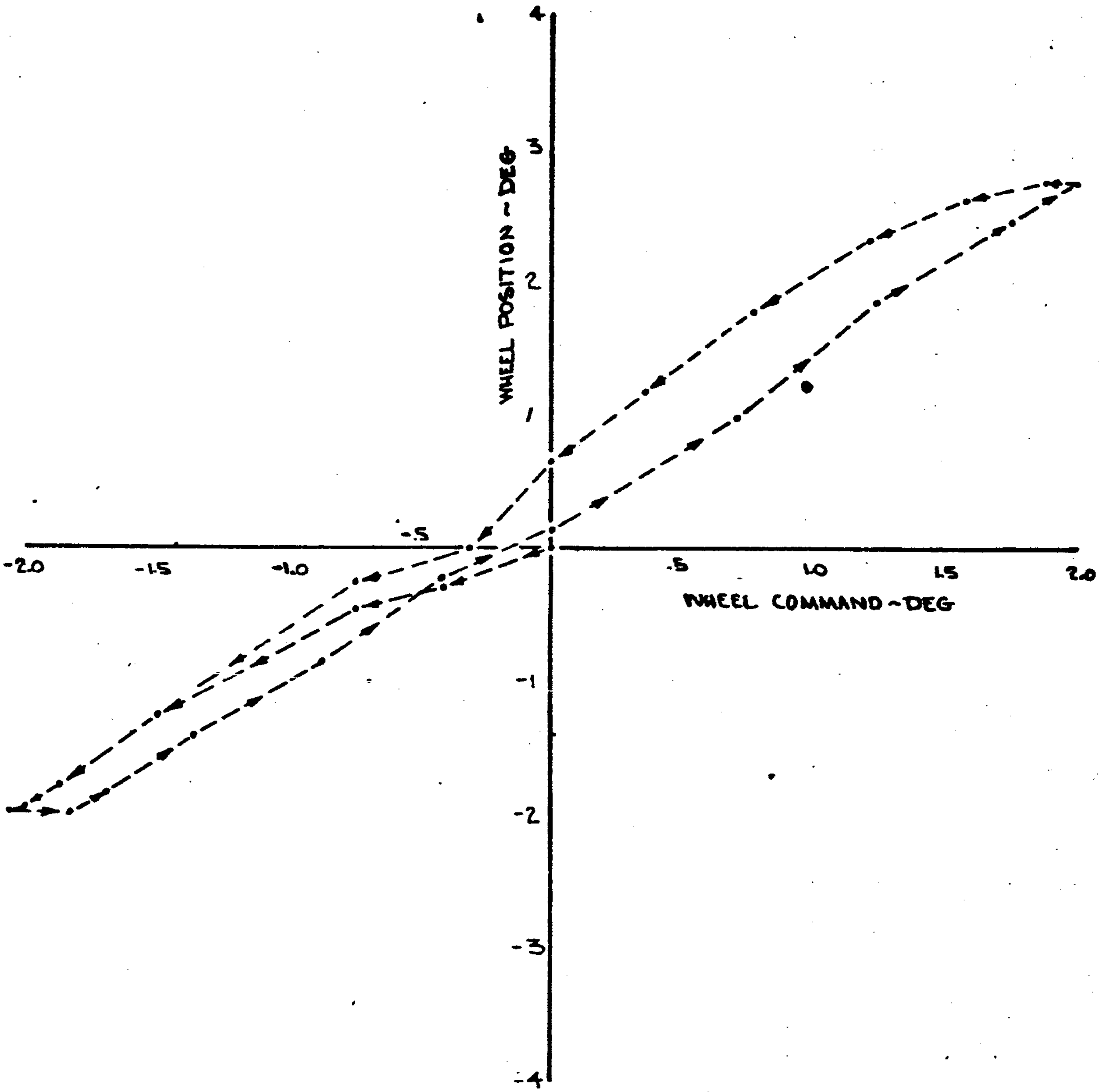
CALC			REVISED	DATE	SPOILER DRIVE ACTUATOR TRANSIENT RESPONSE
CHECK					
APR					TEST NO 655-1 COND. 1.38.03.03
APR					
					THE BOEING COMPANY

FIG. 10



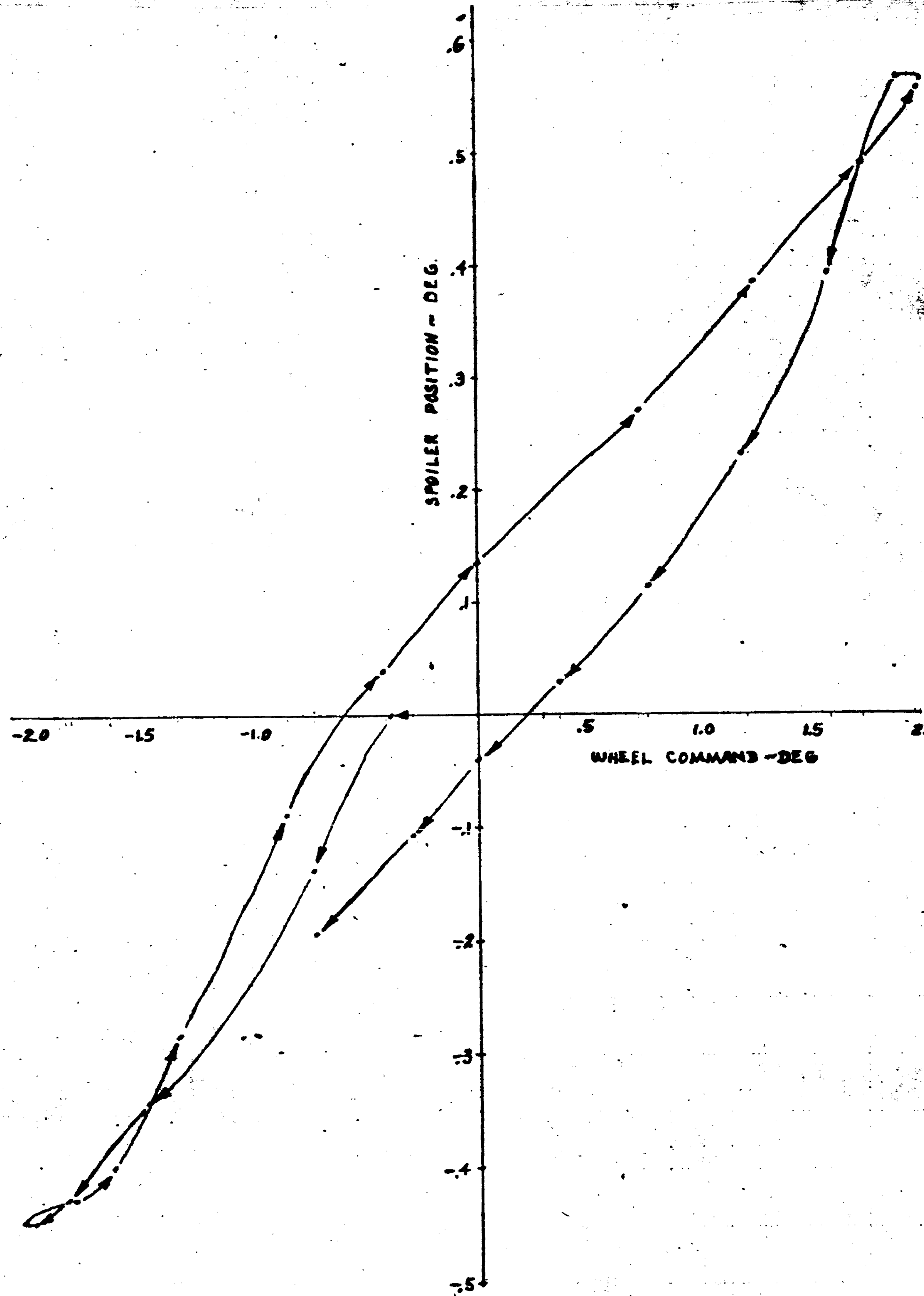
SPOILER DRIVE P.C.U. FREQUENCY RESPONSE

FIG. 11



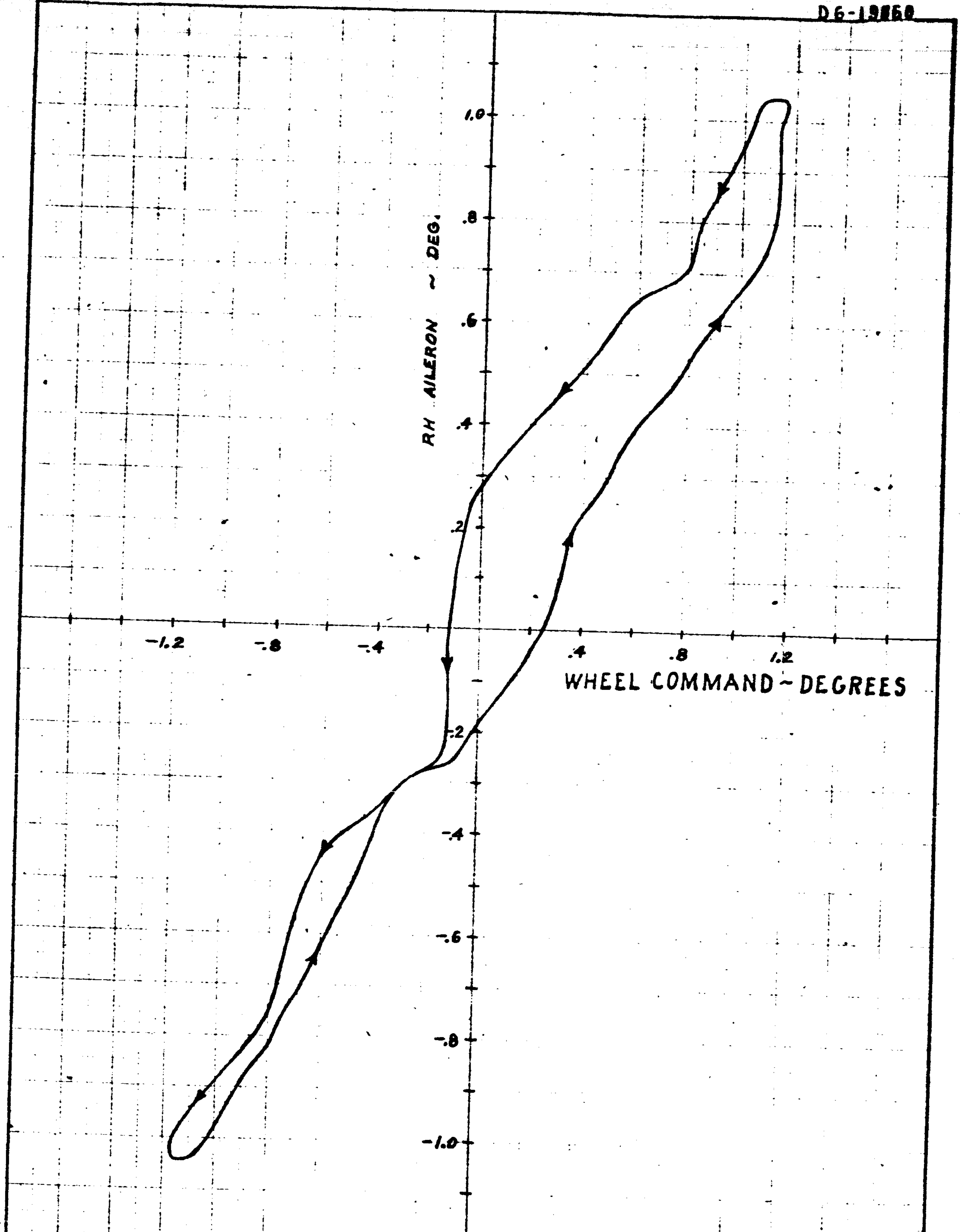
ELECTRICAL MODE

CALC			REVISED	DATE	SPOILER CONTROL SYSTEM HYSTERESIS δ_w VS δ_{w_c}	FIG. 12
CHECK						
APR					TEST NO 655-1 1.38.03.02	
APR					THE BOEING COMPANY	PAGE C15



TEST NO. 655-1 1.38.03.02

D.E. GRAVES 7-7-65	SPOILER CONTROL SYSTEM HYSTERESIS	FIG. 13
	NO. 7 SPOILER POSITION vs δ_{w_c}	
	THE BOEING COMPANY	PAGE C16



CALC			REVISED	DATE
CHECK				
APR				
APR				

SPOILER PCU INPUT TO RH AILERON HYSTERESIS

367-80

FIG. 14

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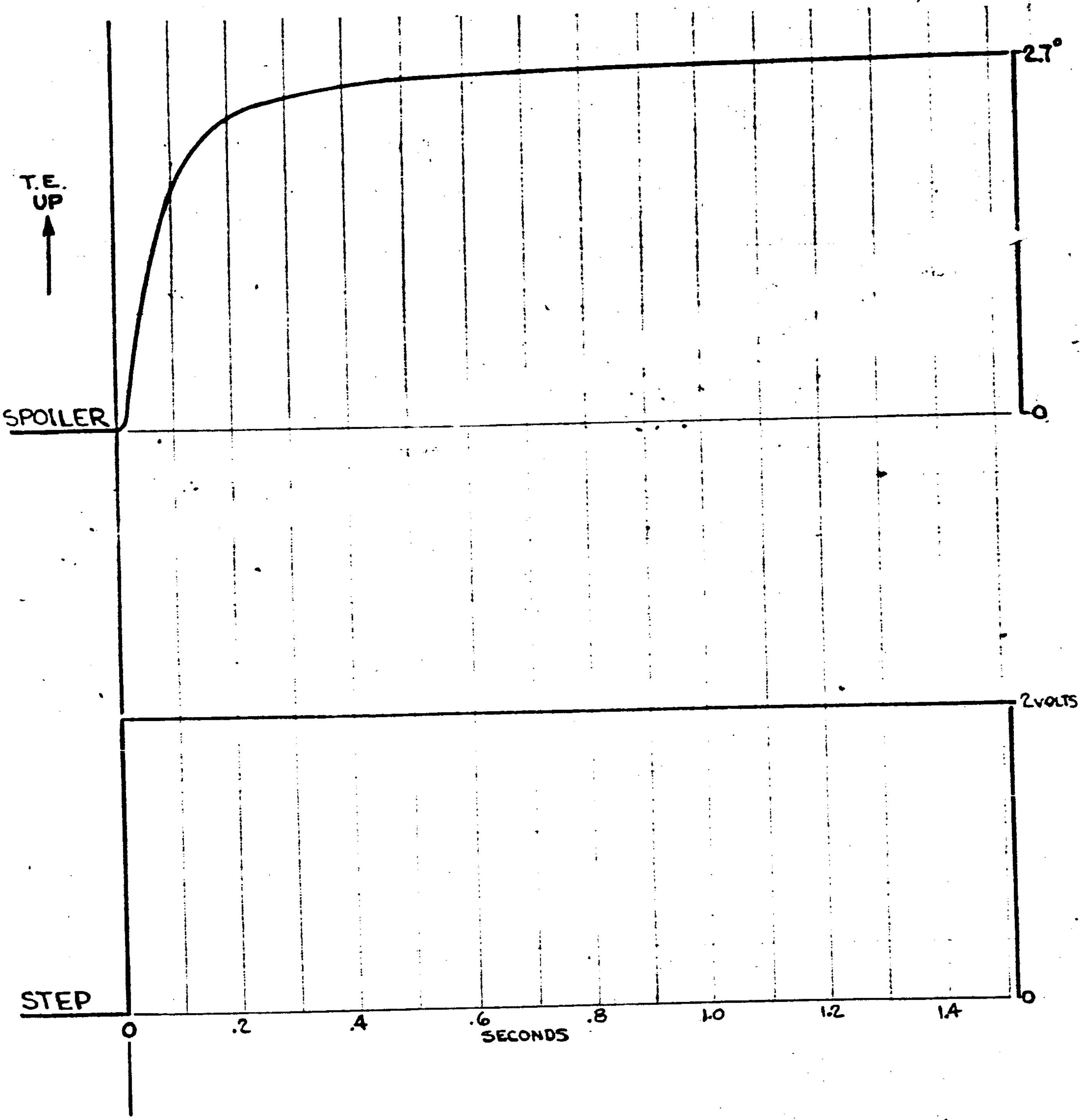
TD 461 C-R4



MAX. NO LOAD RATE = 50°/SEC (ELECTRICAL MODE)

$$\delta_{SP}/E_{IN} \approx \frac{K}{(.06S+1)}$$ LIMIT ±10°

TEST NO. 655-1 COND L38.03.09

			REVISED	DATE	
CALC					SPOILER ACTUATOR #6 TRANSIENT RESPONSE (ELECTRICAL MODE)
CHECK					
APR					
APR					THE BOEING COMPANY

FIG. 15

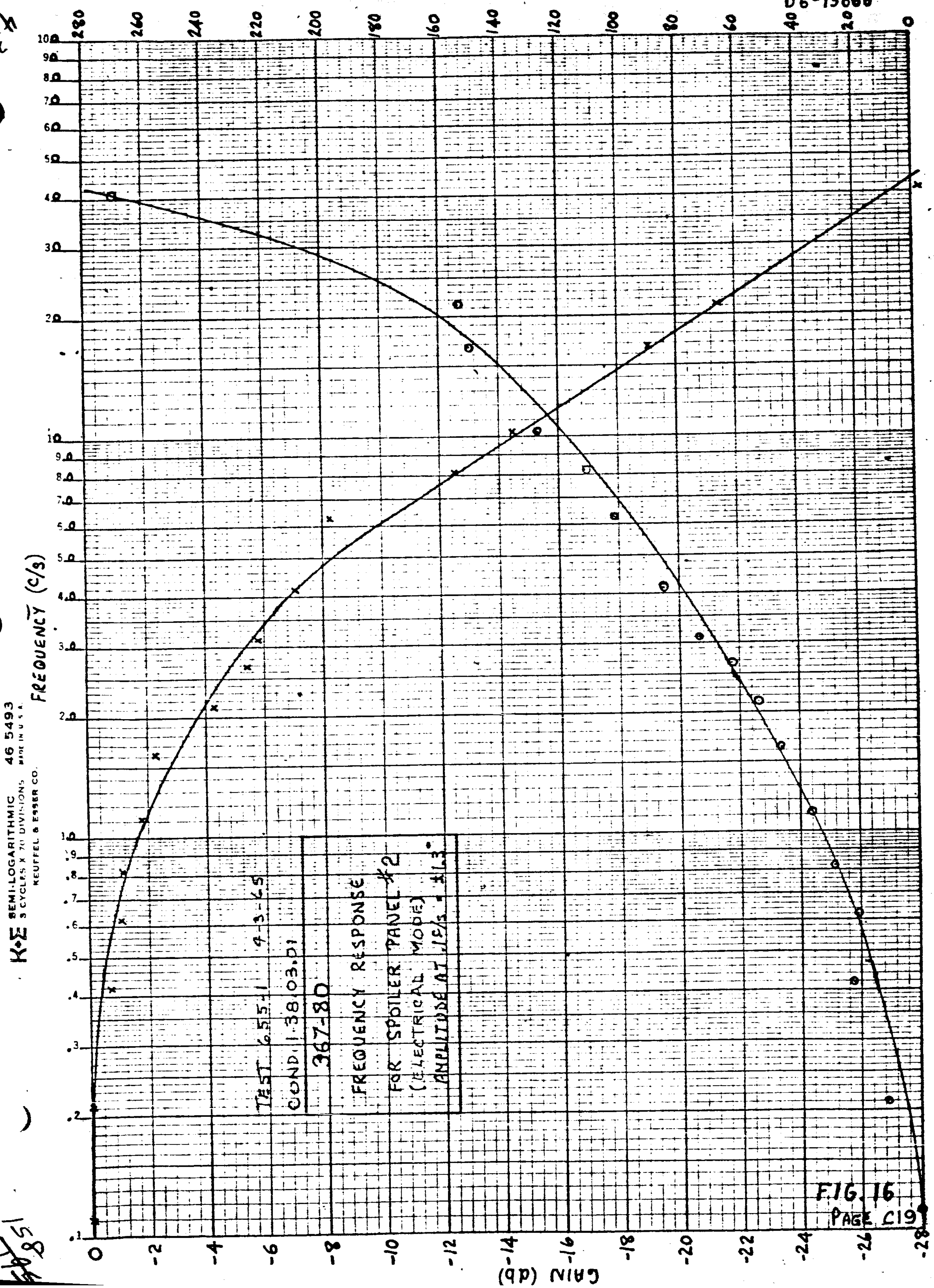
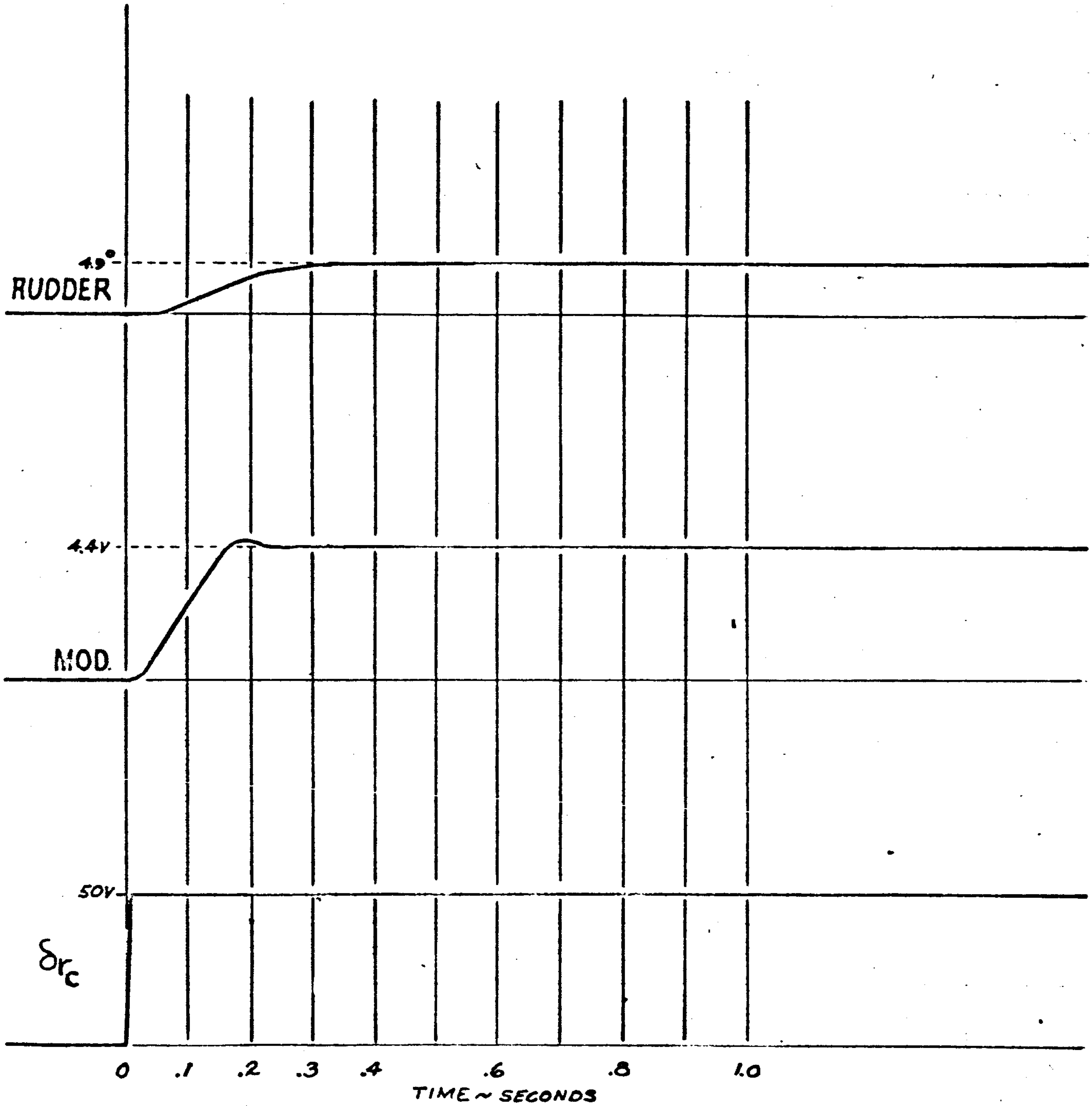

PHASE LAG (DEGREES)
FREQUENCY (C/S)
GAIN (db)
TEST 6.55-1 4-3-65
COND. 1.38.03.01
367-8D
FREQUENCY RESPONSE #2
FOR SPOILER PANEL
(ELECTRICAL MODE)
AMPLITUDE AT 1C/S = ±1.3°
K+E SEMI-LOGARITHMIC 46 5493
3 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

FIG. 16



MAX NO LOAD RATE = 33 °/sec

$$\delta_r / E_{IN} = \frac{K}{(.06S+1)(.028S+1)} \qquad \text{LIMIT } \pm 10^\circ \text{ ELECT.}$$

TEST NO. 655-1 COND 1.38.03.07

CALC	D.E.G.	4-13-65	REVISED	DATE	RUDDER TRANSIENT RESPONSE (ELECTRICAL MODE)	FIG. 17
CHECK						
APR						
APR					THE BOEING COMPANY	PAGE C20

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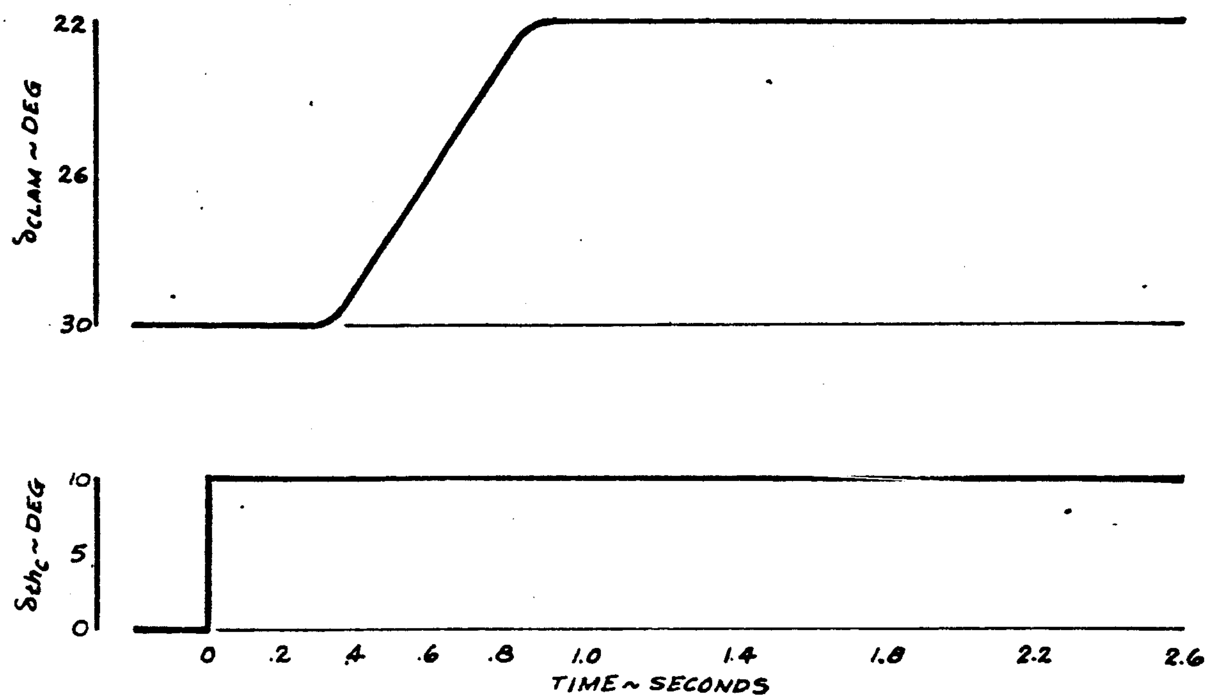

MAX CLAM SHELL RATE = 14 °/sec

$$\frac{\delta_{CLAM}}{E_{IN}} \approx \frac{K}{(.04S+1)(.19S+1)}$$

CALC			REVISED	DATE	THRUST MODULATION SYSTEM ELECTRICAL MODE TRANSIENT RESPONSE	FIG. 18
CHECK						
APR						
APR					THE BOEING COMPANY	PAGE C21

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2						47					
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43						A28					
44						A29					
45						A30					

ACTIVE SHEET RECORD

SHEET NUMBER	REV LTR	ADDED SHEETS SHEET NUMBER	REV LTR	ADDED SHEETS SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR	ADDED SHEETS SHEET NUMBER	REV LTR	ADDED SHEETS SHEET NUMBER	REV LTR
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B2						B47					
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B4						B49					
B5						C1					
B6						C2					
B7						C3					
B8						C4					
B9						C5					
B10						C6					
B11						C7					
B12						C8					
B13						C9					
B14						C10					
B15						C11					
B16						C12					
B17						C13					
B18						C14					
B19						C15					
B20						C16					
B21						C17					
B22						C18					
B23						C19					
B24						C20					
B25						C21					
B26						a					
B27						b					
B28						c					
B29						d					
B30											
B31											
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B35											
B36											
B37											
B38											
B39											
B40											
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B42											
B43											
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164